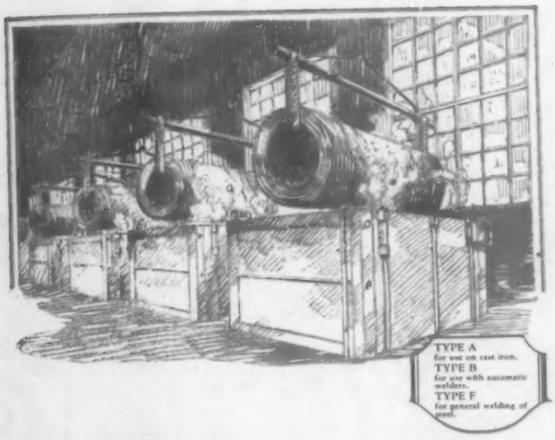
The Welding Engineer

Reg. U. S. Pat. Office

Founded by L. B. Mackenzie, 1916

JULY, 1927 VOL. 12, No. 7

$3.00 per year in U. S. 605 S. Dearborn St., Chicago, Ill. $4.00 per year abroad



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GENERAL ELECTRIC

MERCHANDISE DEPARTMENT, BRIDGEPORT, CONNECTICUT

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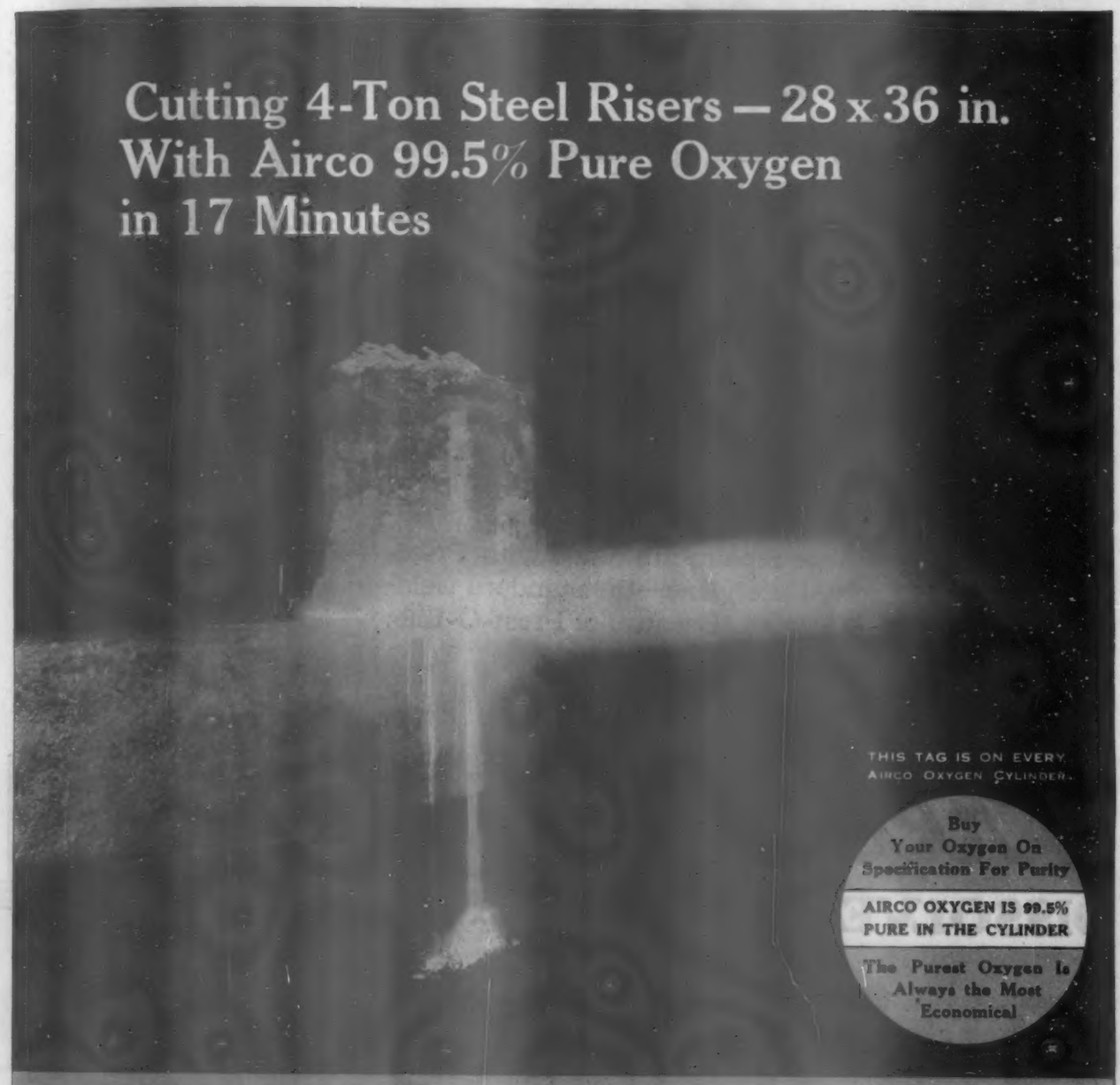
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The Welding Engineer

Founded by L. B. Mackenzie, 1916

Volume 12 | July, 1927 | Number 7

CONTENTS

More Durable Than Wood 29
By William Dalton

Fusion Welding Pressure Vessels 31
By S. W. Miller

Arc Welded Steel Windows 35
By C. M. Rusk

Morehead Metals Presented 37

Reducing Pipe Line Stresses 40

Shop Tests for Welding Rods 47
By P. L. Roberts

Editorial 27

Tensile Tests on Welders' Specimens 36

Arc Welded Spark Plugs 45

Welding on Residential Buildings 46

Use Electric Welding to Strengthen Bridge 48

Stronger Tools Made Up by Welding 49

Suggestions to Lincoln Prize Competitors 50

Welding and Vocational Rehabilitation 51

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MERCHANDISING journals make frequent reference to suits involving infringement of trade mark rights, and sales managers watch these cases with the keenest interest because a vital merchandising principle is at stake. Advertising a trade mark has proven the one sure way to establish the quality of a product before the public. It is the consumer's assurance of getting just exactly what he wants. Naturally no manufacturer wants to divide with competitors the popularity which his trade name enjoys, and for which he has invested large appropriations; neither does he want to risk the harm that might result from the selling of an inferior product under a similar name. Of course, it is only just and proper to protect the firm which identifies the quality of its products in this manner. But let's not lose sight of the importance of all this to the consumer. He needs to know what he is buying. Somewhere in the list of advertised brands he will find the product whose quality is just what he wants. The modern business paper renders a mighty valuable service to its readers by displaying in convenient form the products of a single industry, for study and comparison. The reader gets his information about equipment and materials direct from headquarters and avoids the uncertainties of random selections.

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The Welding Engineer does not publish in its news or advertising columns any matter that deals with or refers to either personal or legal controversies.

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Buyers' Index

Readers of The Welding Engineer will find this index to contain the most accurate information obtainable relating to welding apparatus and supplies. The advertising section includes the principal manufacturers of the United States.

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See "Electric Resistance Welders"

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Joseph Dixon Crucible Co.

Ohio Bell Telephone Bldg., Cleveland, Ohio

Left: Operator at work on one of the 16-inch steam risers. *Center:* Main riser with five manifolds, showing 8-inch welded connections. *Below:* 16-inch flange, welded on both sides of expansion joint.

Why WILSON Welding Wire *was chosen for the* Ohio Bell Telephone Building

BEFORE Smith & Oby, Cleveland plumbing and heating contractors and engineers, started to weld the steam risers that feed fifteen stories of the Ohio Bell Telephone Building, they made test after test in the laboratory to find the welding wire they could depend upon to *hold*. Pieces of 8" pipe were butt-welded, test coupons were cut, and then pulled and bent—the coupons were all machined flush, and welded with the same machine and by the same operator. *In these tests the welds made with Wilson "Color-tipt" Welding Wire were the only ones that broke outside the weld.*

That is why Smith & Oby selected Wilson Wire for *every weld on the job*—for every weld on the 16-inch riser that extends through fifteen stories, and for every weld on the distributing risers that feed up and down from the fifteenth floor. Wilson Grade No. 6 (Patented U. S. A., June 13, 1916; March 9, 1920; Canada, March 19, 1918) and Wilson Grade No. 9 (Patented U. S. A., June 13, 1916; March 9, 1920) were used.

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International Oxygen Co.
K-G Welding & Cutting Co.
Milburn, Alexander, Co.
Modern Engineering Co.
Oxweld Acetylene Co.
Torchweld Equipment Co.
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SPOT WELDERS
See "Electric Resistance Welders"

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Modern Engineering Co.
National Carbon Co.

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C. Sorensen

WELDING RODS AND WIRE
See "Electrodes" and "Filler Rods"

ALPHABETICAL INDEX TO ADVERTISERS

A

Air Reduction Sales Co. 3
Allan Mfg. and Welding Co. 61
American Brass Co., The 53
American Welding Society .....
Anti-Borax Compound Co. 66

B

Burdett Oxygen Co. 57
Burke Electric Co. 65

C

Carbic Mfg. Co. 62
Carbide and Carbon Chemical Corp. 62
Central Steel & Wire Co. 19
Chicago Steel & Wire Co. 58
Commercial Acetylene Supply Co. 60
Craftsweld Equipment Co. 63

D

Dixon Crucible Co., Joseph 62
Dunham, Keith, Co. .....

E

Elec. Arc Cutting & Welding Co. .. Back Cover
Electric Welding Machine Co. 15
Elkon Works, Inc. ..... Inside Back Cover

F

Federal Machine & Welder Co. 59
Fibre Metal Products Co. .....

G

Gas Products Assn. .....
General Electric Co. ..... Front Cover, 13
Gibb Welding Machine Co. 64
Goodman Electric Mach. Co. 66

H

Harris Calorific 10
Heylandt Sales Co. 66
Hollup, C. H. .....
Hoxite Company .....

I

Ideal Face Shield Co. 65
Imperial Brass Mfg. Co. 66
International Oxygen Co. 64

K

Kerotest Mfg. Co. 55
K-G Welding Co. 57

L

Lincoln Electric Co. 16
Lincoln Steel Co. .....
Linde Air Products Co. 2
Lundy, E. A., Co. 26

M

Mattice Engineering Co. 61
Metal and Thermit Corp. .....
Modern Engineering 17
Morey Flux & Chemical Co. .....
Moto Meter Co. 14

N

National Carbon Co. 12
National Gauge and Equipment Co. 14
National Carbide Co. 58
Northwestern Mfg. Co. 61
Norgren, C. A., Co. 66

O

Owen Electric Mfg. Co. 21
Oxweld Acetylene Co. 28

P

Page Steel & Wire Co. 59
Pierce, R. C. 66
Pressed Steel Tank Co. 65
Prest-O-Lite Co., Inc., The 4

Q

Quasi-Arc Weltrode Co. 66

R

Reid-Avery Co. 11
Roebling, John A., Sons Co. 23

S

Seneca Electric Arc Welder Co. 62
Sofensen, C. 54
Shawinigan Products Corp. 63
Standard Steel & Wire Co. 54
Stevenson Distributing Corp. 64
Steel Sales Corp. 56
Strauss & Buegeleisen 66
Strand, N. A., & Co. 66
Stulz-Sickles Co. .....
Stoody Co. 61

T

Taylor-Hall Welding Co. 54
Thomas & Co., R. D. .....
Torchweld Equipment Co. 55

U

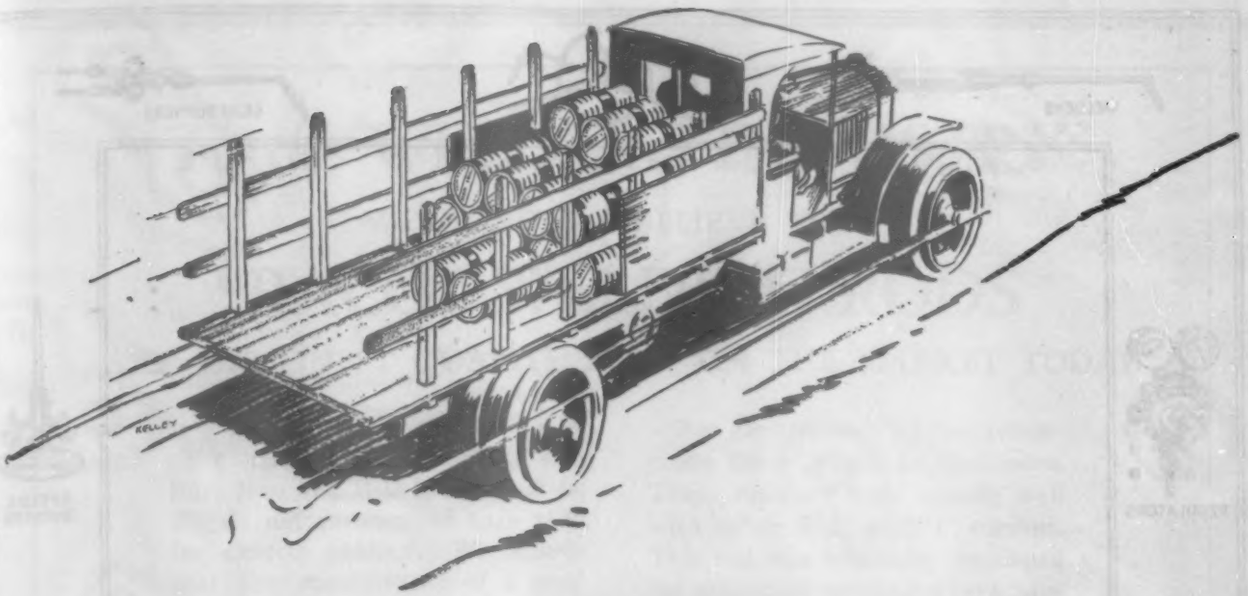
Una Welding & Bonding Co. 20
Union Carbide Sales Co. 9
U. S. Welding Co. 10

V

Vulcan Electric Brazing Co. 54

W

Waters Arc Welding Corporation 56
Weldene Corporation 63
Weldit Acetylene Co. 64
Welding Service Co. 63
Westinghouse Electric & Mfg. Co. .....
Wickwire, Spencer Co. 60
William Wharton, Jr., & Co., Inc. 65
Williams & Co., Inc. 62
Willson Goggles, Inc. 65
Wilson Welder & Metals Co. 7
Wodack Electric Tool Corporation 54



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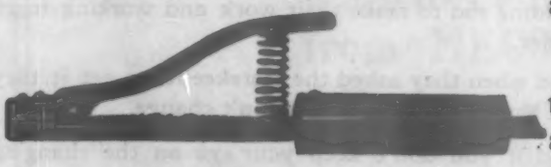

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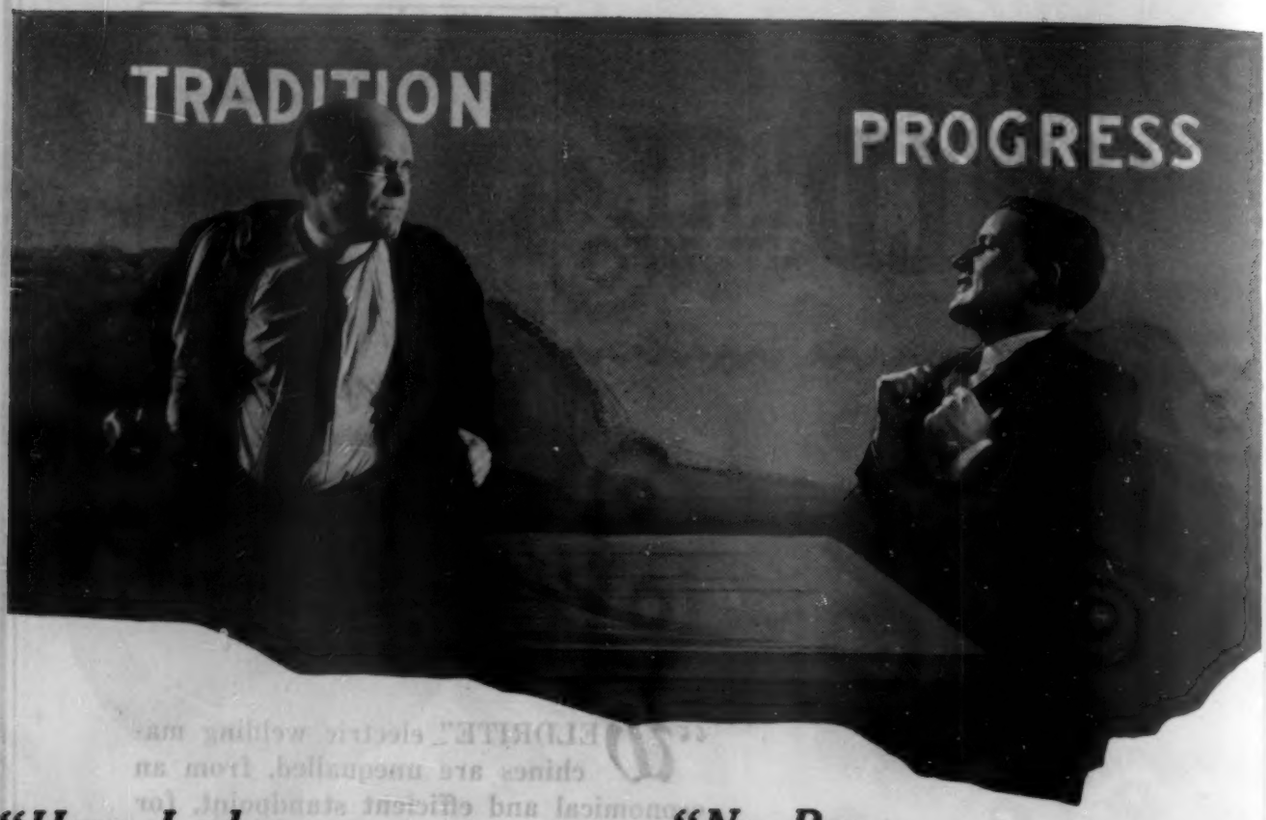

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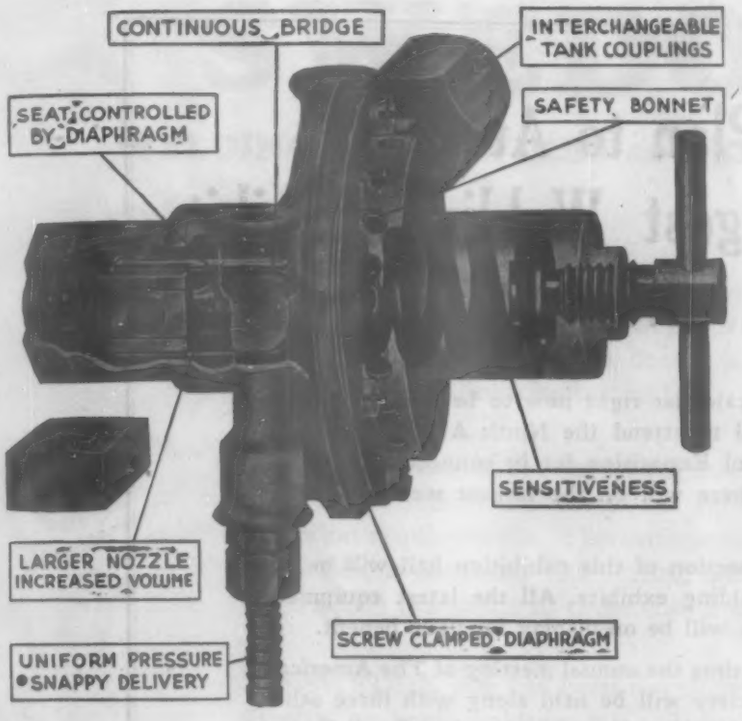

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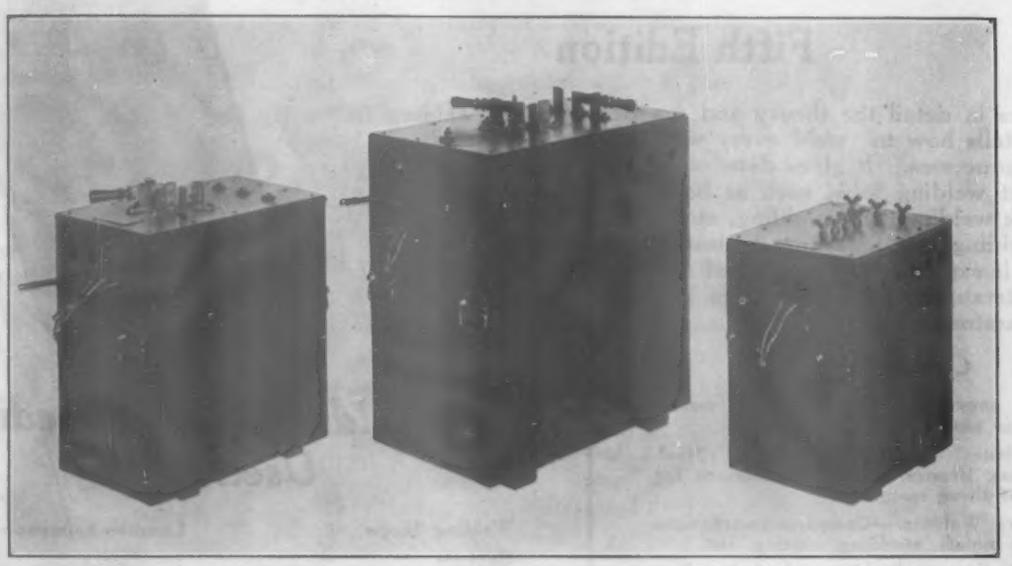

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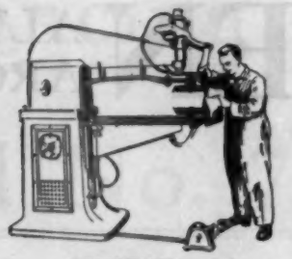

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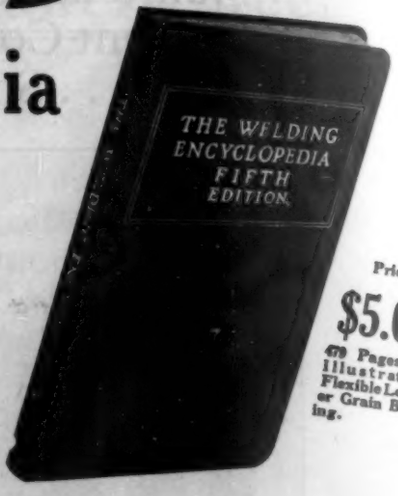

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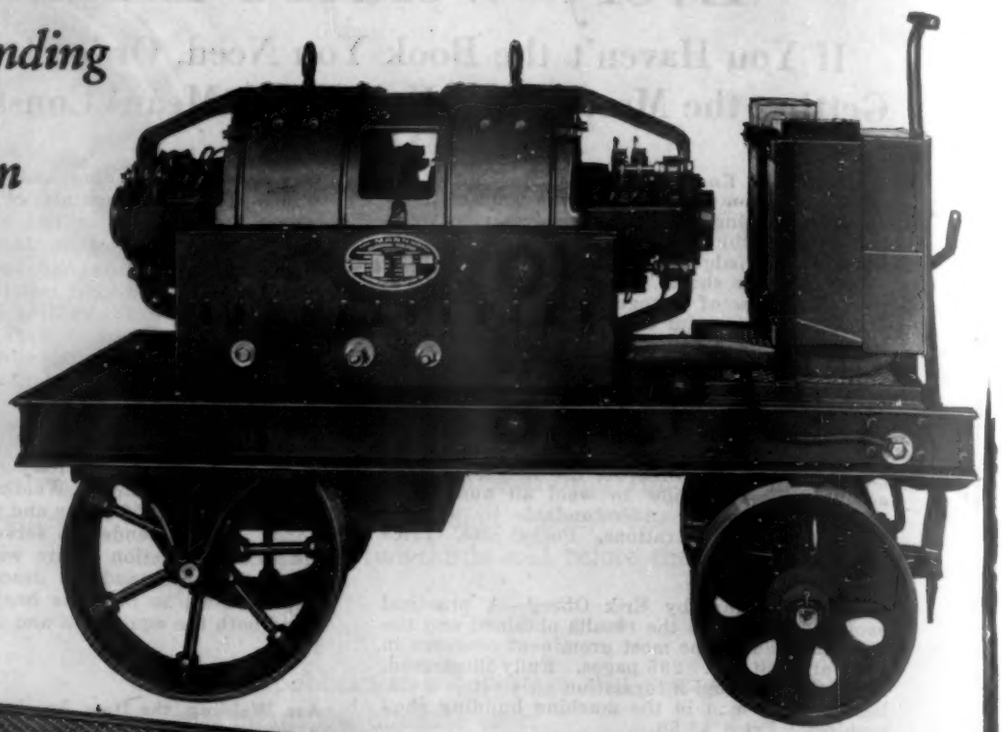

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EDITORIAL

A Few Comments on a Circular

CONSIDERING the extreme youth of the welding industry, it is showing very encouraging signs of thriving under the influence of good habits. It is expanding in all directions and gaining respect everywhere in the world in industry. Good merchandising methods are a help in keeping that respect, and have been encouraged by various group activities. When attention is called to such ill-advised procedure as the circulation of unwarranted claims, it is difficult to refrain from making harsh comments, because the general good seems to demand it. On the other hand, the claimant may justify his stand by assuming an altogether different interpretation from that made by the reading public. The wiser heads in the industry are diligently educating the public along conservative lines, establishing as facts only those things which are capable of proof, and completely ignoring the occasional attempt to corral business by statements that overreach. Such things are only occasional in this industry, partly because welding has so much merit that the truth will sell it, and partly because its growth began during a period in our commercial history when emphasis was being strongly placed on ethical merchandising methods. The responsible manufacturers of equipment and materials for welding are a far-seeing lot, too. They know that the possible demand for their products is far in excess of the supply. They also know that the work done up to date has not furnished a basis for many sweeping comparisons. Naturally they see more to gain by pioneering than by quarreling. If there were a great deal of thoughtless merchandising going on it would be a real problem to discourage it without being misunderstood. Fortunately there is not. Let us hope that there will not be for some time to come. Unfounded and unsupported claims for the superiority of a particular process can be treated with tolerant silence up to a certain point, but if this treatment inspires a volume of it, along will come an outburst of counter claims. Then the industries which should be increasing their volume of welding will sit back and wait for the fight to be over, figuring that this will be the best time to pick a winner. The time is here to sell welding to industry. Every manufacturer can afford to stick to that theme; the market is big enough, and the product is good enough. No permanent good can come from trying to sell anything which doesn't exist. Sell welding.

Good Welders Can Qualify

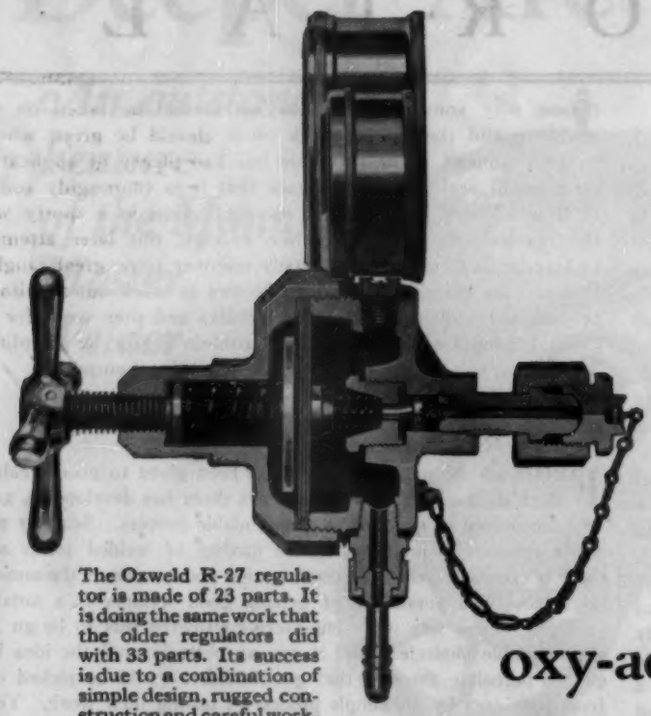
LET the welding industry take a look at a few experiences with systems which closely approach the often proposed plan to license operators. A large chemical plant obtains perfectly satisfactory welded pressure vessels by conducting its own tests on welders who do its work. A job shop owner tests his men before allowing them to work on important jobs, and gets customers hundreds of miles away, over the heads of intervening competitors. An organization in the West requiring members to qualify by test, is thriving and popular. A tank manufacturer who tests his men reports no weld failures in many thousands of tanks. In all of these cases the testing is done intelligently, and the result is a convincing refutation of the theory that good welders are hard to get, or not dependable after you get them. Employers need to be convinced that it pays to make these tests, and that it would be advantageous for all concerned for every good welder to carry an authentic certificate of his ability. Because it is difficult to bring this about is all the greater reason why some concerted action should be taken on the problem, and those who work on it should be given wholehearted support. The principle has had plenty of application on a small scale to demonstrate that it is thoroughly sound. If it is allowed to spread in its application in a spotty way the results will be worth while enough, but later attempts to standardize systems may easily uncover some great tangles. It would be simpler and more effective to work out a uniform procedure for identifying skilful welders and then work for its general adoption. The training problem might be simplified if welders had a greater incentive to train themselves.

Getting Rid of a Problem

FROM all the publicity which has been given to good welding methods during the past ten years there has developed a general acceptance of welding as a dependable process. Scarcely any doubt remains about the possible quality of welded joints and there is comparatively little conversation about some of the ancient bugaboos. The possibility of getting good welders is a notable example. Time was when engineers considered this to be an insurmountable obstacle. And it was an obstacle until the idea began to percolate through that good welders could be picked out from poor ones by the simple process of testing their work. Year after year a few of the stout-hearted pioneers in this industry have urged employers to test the skill of their welders at regular intervals. Here and there a few began to follow this advice, with results that proved to be astonishingly good. Lately it has come to be quite common practice to test all welders on important work and also to mark every weld made on such work so that each individual welder can be made responsible for his own product. It is a natural consequence that greater dependability is being placed on welded structures and on welding as a means of joining metals. The bending test, crude as it is, can be very useful to the supervisor who knows welding intimately; the tension test is desired in many cases because it gives a quantitative result, and will become more popular when simpler apparatus is available; the vibratory test is often more desirable than either of the others, and apparatus for it is quite readily made by a good mechanic; the microscopic test is a big help in important work, but is a highly scientific one involving expensive apparatus and a skillful metallurgist. Tests have to be suited to the conditions, with the greatest importance being attached to the principle of making sure that the test used is sufficient. Nobody will profit more from this than the welder himself. This has been demonstrated by many instances where welders, finding their work below standard, have looked for the cause, corrected it, and found little difficulty in becoming as good as they thought they were. But the employer with large investments in material and equipment at stake cannot afford to minimize the weld for a close record of the quality of labor he hires. Selecting operators cannot help being a problem if it is done by guess. It ceases to be a problem when it is done methodically.

Proper Control Will Decrease Restrictions

AFTER finding out how to use welded joints satisfactorily in building operations, the next step is to get permission to use it, because all kinds of building operations are necessarily subject to codification. Welding codes are just beginning to arrive, and are going to be very important to the industry. Thoughtful engineers in the industry will study proposed codes with exacting care to see that they safeguard the best interests of all concerned. The best opportunity for rapid progress lies in checking the application of each process in sufficient detail to avoid failures. What shall be welded is not so important as how it shall be welded.



The Oxweld R-27 regulator is made of 23 parts. It is doing the same work that the older regulators did with 33 parts. Its success is due to a combination of simple design, rugged construction and careful workmanship. It is not a nozzle type regulator. It has exceptional flow capacity for this reason and will work without freezing. Several years of service in both high and low temperatures have shown it to be simple, sturdy and reliably accurate.

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Just think it over. After a certain period of service the regulator seat needs to be replaced. That's what happens in any regulator. It usually happens at a time when it is most inconvenient. Yet with the R-27 regulator you can have a reconditioned unit in a few minutes, at a cost of a few cents. In fact, the whole "inside works" costs only $3.60.

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WELDING AND CUTTING APPARATUS

More Durable Than Wood*

How Unserviceable Rails Are Converted into Railroad Ties by Ingenious Application of Arc Welding

By William Dalton

THE purpose of a railroad tie is to hold the rails to gauge and to prevent vertical deflection under concentrated wheel loads. These loads may be as great as 40,000 lb. per wheel in the case of locomotives. The soil upon which the ties are laid is resilient and is usually capable of supporting only 6,000 to 8,000 lb. per sq. ft. In order to limit the bending and fatigue of the rail, each tie should have its lower bearing surface made as large as possible. Minimizing the deflection of the rails under the wheels also reduces the hauling power required.

For design calculation, a tie may be considered as a beam supported at two points five feet apart with a uniformly distributed load. It is subjected at the top to a severe side pull due to the tractive effort of the locomotive, or to the drag of the train when the brakes are applied. All movement of the tie in the ballast must be prevented and the tie so proportioned that it will not be tipped over by the pull of the rail through its anti-creeping device.

Such conditions can be met in tie construction by the use of timber, steel, or reinforced concrete. Timber has universally been used because of its low cost and adaptability to track construction.

Fig. 1. A Typical Section of Track Using Arc-Welded Ties Made From Scrap Rails.

In most all other modern structures, it is no longer used as a beam. The constantly increasing cost and decreasing quality of timber ties, and the possibility of getting much more structural strength per dollar from other material, has led to an investigation of possible substitutes. This investigation assumes even greater importance when it is realized that the speed and safety of trains are now limited as much by the strength of the track as by any other factor.

A study of various designs shows that reinforced concrete is not well adapted for making cross ties, but rather that a continuous concrete slab is better suited as a foundation for the track. The design of such a slab presents more difficult problems than the design of a metal tie and the solution of these problems makes the concrete slab more expensive.

Taking up the design of a steel tie, three distinct problems are encountered, *viz.*, the tie design, the design of a dependable rail clamp, and the production of a cheap insulator for main line signaled service. The first two problems must be solved as one; but the third can be considered separately, since about 40 per cent of the present track is located in yards and sidings and is not signaled.

The H-section beam gives the maximum strength per pound of metal. When used as a tie, however, it slides very easily in the ballast in both directions. This movement can be stopped by fastening bars to each end of the tie beam and making these bars the same length as the spacing of the ties in the track. The tie beam must be wide at the bottom to provide bearing surface on the ballast, and it must be wide enough on top to give sufficient bearing against the rail to prevent the anti-creeping device from tipping it. The punching of any holes in the tie-beam flange, for rail clamps or fasteners, weakens the flange. This can be avoided by fastening separate plates to the tie beam. If the rail fasteners are placed on the outer edge of the beam, the wave action on the rail strains the fasteners severely and

Fig. 2. A Close-up of The Metal Tie.

the flange of the tie beam is also fatigued at its junction with the web. It is, therefore, better to use fasteners located over the center of the tie. These conditions can best be met by using two beams held together at the top by a tie plate and at the bottom by the end bars needed to prevent movement in the ballast. Using two beams instead of one gives the greatest bearing surface on the ballast with a minimum height. As the edges of the tie plate can be placed over the center of the flange of the tie beams, the wave action of the rail throws the load directly over the webs of the beams instead of on the outer edge of the flanges. Such a design also reduces the number of rail clamps to a minimum.

Arc welding has been tried as a means of fastening the parts together; and a year's test, under severe track conditions, has demonstrated its value for this service. The use of welding makes a variety of designs possible, some of which are shown in Fig. 2. If made of new metal, the cost will prohibit the economical use of any of these designs at the present time; but, if made of scrap material, they are worthy of careful consideration. As the welding becomes the largest item of cost, next to the material, the arrangement which uses the least amount of welding will prove to be the cheapest.

Worn rail, which is taken from the track in large quantities yearly, offers a very convenient supply of scrap material for this purpose. By the use of automatic welding machinery, the "worn

* *Courtesy of General Electric Review.*

rail" tie can be produced for about 60 cents, to which the scrap value of the old material must be added. This value, however, will be recovered when the tie is discarded. The cost of the tie plate, which must also be added, will be the same as for wood ties.

To make a fastener for a metal tie, it is necessary first to decide whether the tie should be made suitable for any section of rail or if it is satisfactory to limit its use to a particular section that is standard for the road in question. Since the gauge of the track is a constant, the rail fasteners for general use would be required to accommodate three variables: thickness of rail head, which governs the distance center to center of the rails; width of flange; and thickness of flange. The design of a fastener for a special section, however, would be affected by the flange thickness alone, the range of which is small. The standardization of the width of rail heads and flanges and thickness of flanges becomes a matter of great importance when metal ties are considered. The fastener must be safe and secure under the hammer-blows from heavily loaded and rapidly moving wheels. It must be simple and quickly applied without the use of special tools. Many designs are based on the use of bolts and rivets, but these tend to rattle loose in service and require constant attention. Two designs are shown in Figs. 3 and 4. The

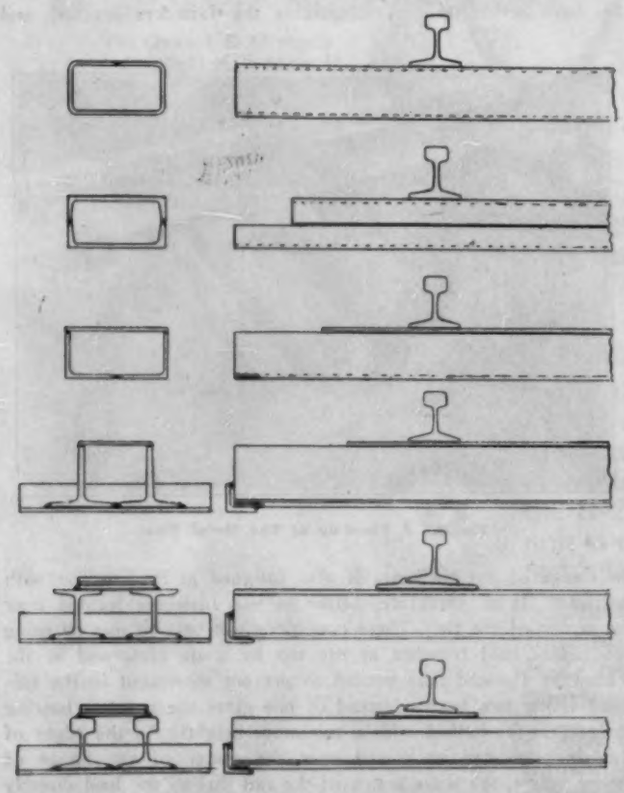


Fig. 3. Various Designs of Welded Ties. The One at The Bottom is Made From Scrap Rails.

former is for a universal tie plate which will take any section of rail by making the rail clamp suitable for that particular section. It is made of rolled shapes sheared to length. It has stood a year's trial in service without showing any sign of weakness and has required no attention from the track men. The other design is simpler. It is applicable only to ties made for a particular section of rail as the flange on the tie plate is used to keep the rail from spreading. It also can be applied quickly and pried loose with ordinary track tools.

By test it has been found that these metal ties are very satisfactory in service. They have a greater bearing surface on the ballast than have wood ties. There is no movement of the tie in the ballast. The rail clamps are more dependable than spikes and the tie can be put in place and clamped to the rail more quickly than the rail can be spiked to gauge on wood ties. The tests show that four spikes driven in a wood tie will fail under side loads ranging from 12,000 to 15,000 lb. Furthermore, the tests show that the clamping devices just described are ten times as effective in keeping the rails from spreading.

It is an easy matter to make a track insulator, but it is difficult to make a cheap one that will stand heat, cold, moisture, acid, alkalies, and the severe mechanical punishment to which it is subjected between the rail and the tie plate. It must be able to withstand at least 1,000 lb. per sq. in. pressure and also the abrasion due to the creeping of the rail. Several materials are being investigated, but it will take a long time to make the necessary service tests to determine the cheapest satisfactory material. Canvas impregnated with bakelite promises good results. It withstands shock and wear when used in gear teeth and, apparently, has all the necessary qualities. This investigation will be continued as the metal tie and fasteners have proved their dependability in yards and are now available for insulator tests.

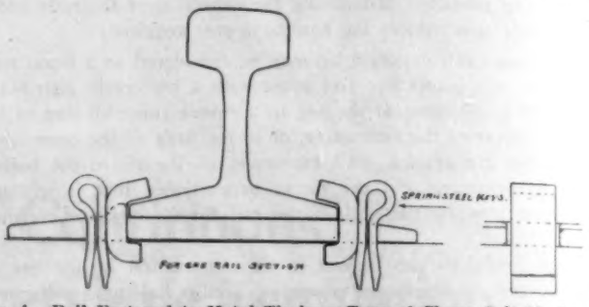


Fig. 4. Rail Fastened to Metal Tie by a Type of Clamp Suitable for a Variety of Different Rail Connections.

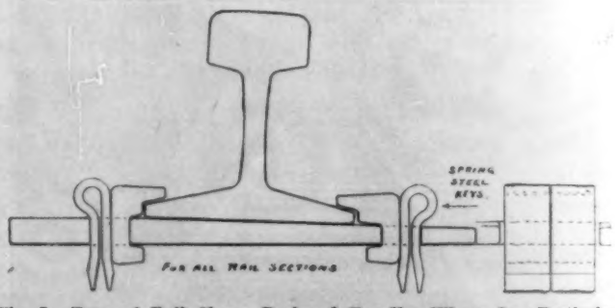


Fig. 5. Type of Rail Clamp Designed For Use Where One Particular Rail Section Has Been Adopted as Standard.

The present tendency in railroad service is toward heavier trains and higher speeds. Train speeds are now limited by the strength of the track. It may take years of experience with installations in yards and sidings to establish confidence in any substitutes for the present main-line construction. The purpose of this article is to point out one substitute that is many times stronger than the wood tie and one which can be tried extensively at a very low cost.

WELDING MAKES POSSIBLE ROLLING STRIPSHEETS ON CONTINUOUS MILL

Pickling of stripsheets before cold rolling has been greatly facilitated by welding to form a continuous sheet. The method is described by John D. Knox in an article in the Iron Trade Review, one of a series on continuous rolling of stripsheets.

The hot rolled coil is fed from a spindle at the starting end of the pickling equipment through a roller leveler and then into a spot welding machine. The front end of the oncoming coil is lapped with the tail end of the sheet already in process. When the lap is completed both ends are held down by magnets and while the welding truck moves forward with the stripsheet, the material is spot welded at will across the lap. From the roller leveler to the entrance of the pickling vat is about fifty feet, and by the time the welding machine has traveled this distance the weld is completed.

Upon completion of the pickling process a shear makes a cut on both sides of the weld and the severed portion containing the joined ends is remelted. The method of facilitating continuous operation greatly reduces the handling costs.

Fusion Welding Pressure Vessels*

Exacting Specifications of Purchaser and Close Supervision of Workmanship Make Possible Safe Welded Construction

By S. W. Miller

THE primary function of the members of your Board is to conserve and increase public safety. A structure that is safe in one state or community is safe in any other state or community. It is equally true that a dangerous structure is dangerous wherever it may be located, so that the importance of your work lies largely in seeing that safety is made uniform through the United States.

There are, of course, different conditions in different communities, and the laws which you have to enforce may be different in different states, but I am quite sure that your ultimate objects are the production and enforcement of proper laws that are uniform throughout our country.

I am quite in accord with this program, and as much of my work is with fusion welding, I am especially interested in having such laws provide not only for safe welding construction, but also for the future safe development of the processes.

It is, I think, quite natural that any process whose development has been rapid should result in some bad work being done. This was true of reinforced concrete, and even of plain concrete in its early stages of development. It was true in early days of electric lighting. In fact, the history of civilization has been a history of education in the ways of arriving at success, and in all cases we have learned by our failures. We have learned to avoid dangerous materials of construction. We do not allow electric wiring to be installed in buildings except under adequate regulation and supervision, and we do not permit concrete structures unless they are designed and built in accordance with well-known principles and practices.

In the same way we have learned how to use fusion welding. We do not know all about it, of course, any more than we know all about anything else; but we do have knowledge enough to enable us to say where it can be used safely at the present time, and how its applications shall be made to insure that safety. It may be remarked that the present developments in welding are based on accurate information, and are not empirical, as in the early days. Those who are properly interested in fusion welding know better than to advocate welding of anything unless they are thoroughly convinced by observation and test that it is safe, and because we must keep our consciences clear, we have devised methods which will assure us that our test results may be duplicated in production work.

I shall speak of one instance of how the problems connected with fusion welding have been solved. One of the companies with which I am connected found it necessary to make large storage tanks that were absolutely tight and would stand high pressures, and we saw no way to get what was needed but by fusion welding. These tanks are now in many cases a matter of quantity production, of course under our supervision and inspection. We have not arrived at this point in the development without study and care, nor have we done it too rapidly. On the other hand, we are sure that we have not reached what is ultimately possible, and we cannot afford to consider that we will not get any further in our development work, because the possibilities for effecting economies are so great as to be exceedingly attractive.

There is no secret in obtaining successful results by fusion welding and they can be obtained in either repair work or new construction by anyone who gives proper attention to all of the elements entering into the job.

In our work, we design the structure ourselves, using our experience and the results of our tests as guides. We specify the materials, including the welding wire, in accordance with our knowledge and experience. We supervise the work ourselves. We make sure by proper tests that the welders are competent and finally we apply adequate tests to be sure that the structure is safe. In each new design we take the precaution of making strain gage measurements all over the structure in order to determine the actual stresses that exist under test and in service. In this way we know that no part is stressed beyond what it should be, and if necessary we can change the design to meet this requirement.

When we began designing fusion welded pressure vessels for ourselves, we used 7,000 lbs. as the working fiber stress. Strain gage measurements at three times the working pressure convinced us that it was safe to use a higher design stress, as we went to 8,000 lb. Repeating the strain gage work showed that 9,000 lbs. was safe, and we are now using this.

In all cases so far we have tested the tanks to three times the working pressure, so that now they are tested to 27,000 lbs. fiber stress somewhat below the yield point of the material which is about 35,000 lbs. per square inch.

We are now having built tanks 7 ft. in diameter, 35 ft. long, and of $\frac{1}{8}$-in. material for 200-lb. working pressure, based on a design fiber stress of 9,000 lbs. per sq. in. The seams are all double V welded with a welding wire whose tensile strength, as deposited in the weld, is about 65,000 lbs. per sq. in., and which has an elongation on an average of about 15 per cent in 2-in.

We have also had built tanks 5 ft. in diameter, about 40 ft. long, of $1\frac{1}{8}$-in. plate for 300-lb. working pressure.

These are made in commercial shops, under our supervision and according to our specification, and I may say that there is just as much thought and care put into their design as is used in any of the rest of our important engineering work, and that we follow the A. S. M. E. pressure vessel code wherever it is possible to do so.

The welders who do the work have to meet the requirement of a minimum tensile strength in the welded test plates made by them in the same material as used for the tanks ,of 45,000 lbs. per sq. in. This must be obtained in test pieces that have the reinforcement removed.

We have invariably found that the welders are anxious to do good work, and are very much interested in the results of the qualification tests. There is also quite a little rivalry among them as to who shall make the best welds. It also should be understood that these welds are not heat treated in any way, but are tested just as they are made.

It will possibly be of interest to see the results of these tests of welders in a typical case, in which six welders were tested, each one making a test plate from which five coupons were cut.

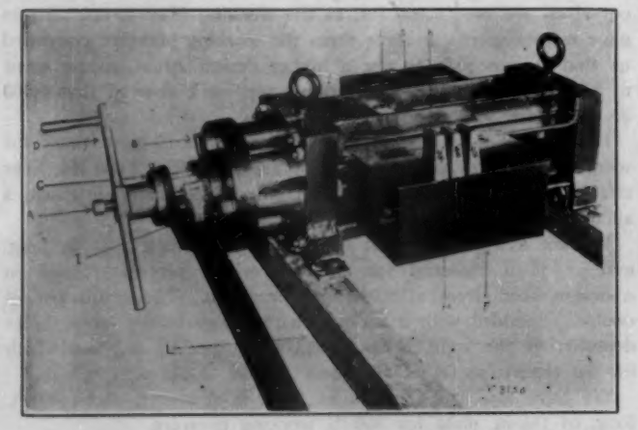
Welder	First Test Ultimate Strength	Second Test Ultimate Strength
A	Maximum 47,700 lbs.	
	Minimum 41,650 lbs.	
	Average 45,800 lbs.	
B	Maximum 61,500 lbs.	
	Minimum 56,800 lbs.	
	Average 59,500 lbs.	
C	Maximum 63,100 lbs.	
	Minimum 52,700 lbs.	
	Average 59,000 lbs.	

*Read before the National Board of Boiler and Pressure Vessel Inspectors, Nashville, Tennessee, June 15, 1927.

D	Maximum 55,000 lbs.	Maximum 63,700 lbs.
	Minimum 41,100 lbs.	Minimum 58,000 lbs.
	Average 48,400 lbs.	Average 60,500 lbs.
E	Maximum 51,700 lbs.	Maximum 55,000 lbs.
	Minimum 39,700 lbs.	Minimum 35,400 lbs.
	Average 47,900 lbs.	Average 44,800 lbs.
F	Maximum 49,600 lbs.	Maximum 60,750 lbs.
	Minimum 17,650 lbs.	Minimum 49,650 lbs.
	Average 39,100 lbs.	Average 54,500 lbs.

Welders B and C were accepted on the first test, while the rest were rejected. After a period of instruction, welders D, E and F were again tested, and welders D and F were accepted.

Quite a while ago we realized the importance of testing welders. The cheapest and easiest way is to bend the test piece in a vise or when clamped to an anvil or other heavy block. This gives a good idea of the penetration and fusion obtained, but does not tell the strength, which should be known if real comparisons are wanted. The standard testing machines were not suitable to meet the important condition of portability so we designed a light, portable tensile machine, with a capacity of 50,000 lbs. It is rugged and so suited for field work, and can be operated by one man. Its accuracy is within about one per cent of that of a standard machine. It is about 4 ft. long and weighs 750 lbs.



Portable Tensile Testing Machine, 50,000 lbs. Capacity.

We believe that it will be a valuable aid in promoting the efficiency of welders.

The A. S. M. E. pressure vessel code allows a longitudinal fusion welded seam with a maximum working fiber stress of 5,600 lbs. per sq. in., provided that the diameter of the vessel does not exceed 20-in., nor the pressure 100 lbs. per sq. in. These provision limit the thickness of the shell to 3/16-in.

On the basis of 60,000 lbs. ultimate strength, 9,000 lbs. working fiber stress gives a factor of safety of 6 2/3. This 9,000 lbs. is so much higher than the allowable stress in the A. S. M. E. pressure vessel code that it may cause you some concern. It is not, however, as high as may appear, because the 5,600 lbs. was taken from some single V test welds examined by Professor R. J. Roark, the results of which are given in a paper read before the A. S. M. E. meeting at Chattanooga in May, 1922. The 5,600 lbs. is not the stress per square inch of plate section, but per square inch of weld section. When reduced to plate section, the figure would be 7,200 lbs. The probable reason that this has escaped attention is that only an abstract of the paper was published in Mechanical Engineering, the preprint being relied on for advance information and as the basis for discussion. The table from which the figure was derived is omitted from the abstract.

The facts are these: The width of the test piece was on an average 1.5-in., its thickness .39-in., the thickness of the weld .50-in., and the ultimate strength per square inch of welded joint of the weakest test piece was 27,800 lbs., or 36,000 lbs. per sq. in. of plate. With a factor of safety of 5, the former figure gave an allowable working stress of practically 5,600 lbs. per sq. in., but, as this was based on the weld section, which was 28 per cent greater than that of the plate, the actual strength of the weld based on the plate section, which is always used in designing, would be 7,200 lbs. per sq. in. The weld from which these tests were taken were inferior, as can be seen when they are compared with good single V welds made with the same kind of wire, which will give about 45,000 lbs. ultimate strength per sq. in. Double V welds when of the same section as the plate, that is, with no reinforcement, will give about 52,000 lbs. per sq. in. as a maximum ultimate strength. Double V welds made with high strength welding rod will give under the same conditions about 60,000 to 65,000 lbs. ultimate strength.

It should also be remembered that the 5,600 lb. figure was adopted in the fall of 1923, and that very great advances in welding knowledge and procedure have been made since that time.

It, therefore, seems that the figure of 9,000 lbs., which we are using at the present time as our basis of design, is not so much in excess of the 5,600 (in reality 7,200), as might appear at first, and it does not look to me at all out of the way to believe that in a short time we will be perfectly safe in using even higher fiber stresses. Ten thousand lbs. working fiber stress, with a weld strength of 60,000 lbs., gives a factor of safety of 6 instead of 5, and as the A. S. M. E. code allows the use of 11,000 lbs. stress in riveted construction, 10,000 lbs. does not seem to be too high.

It seems to be that the best practice must always be beyond any code that may be devised, because progress means going beyond what is being done at present. The important thing is to safeguard the work, so that improvements can be used under proper control. Therefore, it seems to me that all laws in regard to codes or safe practices should contain such provisions as will allow progress to be made when proper authority has been secured, and of course such authority would not be granted unless those administering such laws were satisfied that there was no danger.

I might add that I believe the day is not far off when we will be using with safety still higher design fiber stresses. We have found it perfectly possible to make welds having an ultimate strength of 90,000 lbs. per sq. in., and we have even gone as far as 123,000 lbs. per sq. in. In the former case with a factor of safety of 6, the working fiber stress would be 15,000 lbs., and in the latter case over 20,000 lbs.

I mention these high strengths only to show that much improvement is within sight, though it will require further study before definite practical applications can be made.

An honest inspector has a hard job, no matter what he is inspecting. He is continually confronted by two alternatives, the owner who knows little or nothing about the operation of his plant and who expects it to run without repairs or attention, and the more or less rigid instructions he has received from those who employ him. On one hand his duty requires that he condemn the things that are not safe, and on the other he does not feel like shutting down a plant if it can be run with a reasonable degree of safety. Of course, there are conditions where he has no option but to insist on repairs being made at once, or indeed to order the shutting down of part of the plant. These extreme conditions are, however, rare, and in most cases it is a question of judgment on his part as to what shall be done. For the sake of his reputation he must not run any risk, nor must he be unduly severe. In cases where repairs are needed, he draws on his experience how far the repairs shall go, and by what means they shall be made.

In the case of fusion welding, the average inspector has not himself ever done any of the work, and he, therefore, is naturally cautious about allowing it to be done. The instructions issued by his superiors are usually somewhat indefinite, and simply say that under certain conditions welding can be employed. If the inspector were a good welder, or even if he knew enough about it to tell by watching the operator when a good job was done, or if he was sure that the firm who was doing the work knew that their welders were competent and did good work, he would feel safe, and so would his employers, in allowing more latitude than if these assurances were not had.

Inasmuch as an inspector's efficiency depends on his knowledge,

it seems to me that the time is coming very rapidly when all inspectors will have to know more about fusion welding than they now do, and I appreciate that this is going to be a difficult matter, because their time is almost altogether occupied with their work, and they have not many opportunities to get acquainted with proper methods and practices in welding. However, when a thing should be done some way is always found to do it, and I believe that this part of the problem will be solved, probably not only in one way, but it will be solved.

Further, from what I know of inspectors, they are anxious to find out about all matters that pertain to their profession, and it has been my almost universal experience that where an inspector had an opportunity to learn something about welding, he seizes it eagerly.

I believe that it is the duty of those of us who are advocating fusion welding to give inspectors opportunities to learn more about welding. This can be done by taking one or two of them at a time into a welding shop or laboratory and demonstrating to them just how welding should be done. I would even advocate enough use of welding apparatus by the inspector so that he will have the confidence in his judgment of welding that he has in his judgment of other construction. He should be given opportunities to see the construction of welded pressure vessels, for instance, so that he can become familiar with proper methods and procedure. Such instructions as this cannot fail to increase the value of the inspection to himself, to his employers and to the community.

There are other methods by which an inspector can gain considerable knowledge of welding, such as the welding and other trade papers. Almost all mechanical journals devote quite a little space to welding, and if an inspector reads these, he cannot fail to acquire much information. Many inspectors, however, are not inclined to read very much, nor indeed do they have time, so that I think a personal demonstration is of more value, at least as a beginning.

I would also say that the company with which I am connected will be very glad to help any inspector in any way we can, to get accurate information on any points that he may inquire about, and I shall be pleased to answer any inquiries you may send me.

I believe that the responsibility for good results should be on the manufacturer, and I think it can be definitely put there.

Some time ago, California began the revision of its air pressure tank rules, under the supervision of a general committee. Their sub-committee on welding made certain recommendations as to a procedure control to insure dependable workmanship, and I submit it as an illustration of what may be done, and of the thoughts of some people along this line.

Practically all of the instructions on welding issued to inspectors have been in connection with repair work on boilers, and I think that these are usually correct. The general principle involved is that tension stress must not come on the weld. It is difficult to write down everything that is allowable, but I think you could well consider it one of your important duties to prepare a quite complete schedule of what is allowable, with any comments on materials, methods, and inspection you might care to include. This has been done to a greater or less extent by others, but an official pronouncement by your Board would carry great weight.

I speak of this because more and more fusion welding on repairs will become possible, and the acceptance of such extensions of the process as you approve would be for the benefit of everyone.

APPENDIX "A"

EXCERPT FROM RECOMMENDATIONS OF SUBCOMMITTEE ON WELDING TO SAN FRANCISCO GENERAL COMMITTEE ON REVISION OF AIR PRESSURE TANK SAFETY ORDERS

Outlining Control Procedure to Insure Dependable Workmanship

3. *Authority to Manufacture*:

Manufacturers must be registered by the Industrial Accident Commission before they may fabricate air pressure tanks by means of the fusion welding process.

4. *Basis for Authorization*:

Manufacturers may obtain a permit to fabricate "Cal. X Std." welded air pressure tanks if they agree to comply with the requirements enumerated below, and may annually renew this permit if upon investigation by the Industrial Accident Commission they are satisfactorily carrying out the requirements.

a. Only welders whose workmanship is satisfactory, as determined by methods prescribed in paragraph 5, shall be permitted to weld upon air pressure tanks.

b. Welded air pressure tanks shall be constructed only in accordance with the material, design and test specifications hereinafter prescribed.

c. A complete record of each welded air pressure tank constructed shall be furnished the Industrial Accident Commission, using forms to be supplied by the Commission.

d. Each welded air pressure tank shall be identified by stamping on the tank the name of the manufacturer, the permissible working pressure, the words "Cal X Std.," the year built, and the serial number of the tank corresponding to that given in the report specified in Paragraph "c" above.

5. *Examination of Welders*:

In order to qualify for work on welded air pressure tanks, a welder must pass the test described below to the satisfaction of the Industrial Accident Commission. The applicant shall weld the specimens called for by the process to be used for fabricating the air tanks; or if he desires to qualify for both acetylene and electric welding, a complete set of specimens shall be prepared by each process.

a. Make two specimens joining with a single V weld pieces of ⅜-in. mild steel plate 3-in. wide and approximately 9-in. long of either Firebox, Flange or Class A grades using low carbon steel welding wire meeting A.W.S. Specifications E1A, E1B, or G1A. The pieces of steel shall be cut with their long direction parallel to the direction of rolling and the weld shall be right angles to the long direction of the specimen. The welds shall not be hammered or annealed to improve the properties as the purpose of the specimens is to test the ability of the welder.

b. Make one single V weld joining two ⅜-in. or ½-in. plate 3-in. wide lying in a horizontal position.

c. Make one single V weld joining two ⅜-in or ½-in. plates 3-in. wide lying in a horizontal position.
zontal direction.

d. Make an overhead weld, either joining two ⅜-in. or ½-in. plates 3-in. wide lying horizontal, or on the lower side of an 8-in. pipe held stationary. If a pipe is used, sample shall be cut out of under size for bend tests.

The two specimens described in "a" above shall have the weld milled or ground flush with the plate and have ½-in. cut off each edge, either by machining to the shape of standard test specimen, or by hack-sawing straight down. These specimens shall then be subjected to the standard tensile test in any recognized testing laboratory.

If the strength of either of the two welded joints as indicated by this test is below 40,000 lbs. per square inch, the welder shall not be permitted to work on air pressure tanks.

Specimen "b", "c", "d", shall be bent cold at the weld on a radius not more than 1-in., with the deposited metal on the outside, and shall bend through at least ninety degrees without any cracks appearing at or near the weld. When fracture occurs with

further bending the welded area shall exhibit a homogeneous structure, with no evidence of porosity, slag, or oxide inclusions, or failure of the filling metal of bond to the base metal. If any of these conditions are not met to the satisfaction of the Industrial Accident Commission, the welder shall not be permitted to work on air pressure tanks.

6. *Record of Examination of Welders*:

Each manufacturer shall maintain a permanent record of the examination of welders in his employ whom he permits to work on air pressure tanks, keeping this record on forms to be secured from the Industrial Accident Commission. With this record shall be kept the test specimens on which the record is based, as directed by the Industrial Accident Commission.

Each welder who successfully passes this examination, and is authorized to work on air pressure tanks, shall be assigned a number or other suitable mark, which shall never be duplicated. The number or mark so assigned shall be included in the welder's record submitted to the Industrial Accident Commission. This number or mark shall be stamped by the welder in the metal adjacent to the beginning and end of each seam welded by him.

7. *Periodic Tests of Work*:

In order to make sure that welders working on air pressure tanks are consistently maintaining the quality of workmanship indicated by their initial test, their work shall be checked at least once in each three months, when they shall be required to make test specimens (a) and (d) described in Paragraph 5 above, and if these specimens fail to satisfactorily meet the requirements outlined in that paragraph, the welder shall not be allowed to continue working on air pressure tanks.

GAS PRODUCTS ASSOCIATION HOLDS CONVENTION AT MONTREAL

The 13th Midsummer Meeting of the Gas Products Association is being held at the Mount Royal Hotel, Montreal, on July 13, 14, 15 and 16. Following are the principal events on the program:

WEDNESDAY MORNING

July 13, 1927, 10:00 A. M. Open Meeting

Registration

Address of Welcome.....Mayor of Montreal

Roll Call.....A. J. Russell

President's Address.....H. B. Pearson

Report of Secretary

Report of Treasurer

Development of the Oxygen Industry in Canada.....

.....A. S. Turnbull,

Sales Manager, Canadian Liquid Air Co., Ltd.

WEDNESDAY AFTERNOON

July 13, 1927, 2:00 P. M. Closed Meeting

Report of Technical Committee on Cylinder Investigation, Purging Bottles and Manifolds—

E. G. Luening, Chairman

Discussion of Developments Relating to Corroded Cylinders Since the January Meeting in Chicago—

G. O. Carlson, Engineer, Wm. Wharton Jr. & Co. Easton, Pa.

Discussion of Methods and Means for the Insertion of Cylinder Calves Into Cylinders to Make Up a Tight Threaded Joint—

E. G. Luening, W. F. McKay

Open Meeting, 2:00 P. M.

Apparatus Group Will Meet in a Committee Room to Discuss Matters Relating to the Apparatus Industry—

A. J. Fausek, Chairman

For the Ladies—Drive to Lookout Mountain, leaving Mount Royal Hotel at 3:00 P. M. (This trip will require about two hours.)

THURSDAY MORNING

July 14, 1927, 10:00 A. M. Open Meeting

Welding in Connection with the Plumbing, Heating and Ventilating Trades—

Prof. S. E. Dibble, Carnegie Institute of Technology, Pittsburgh, Pa.

Welding as Applied to Steam and Hot Water Heating Systems

G. W. Macauley, Grand Rapids Welding Supply Co., Grand Rapids, Mich.

History of the Carbide Industry—

R. A. Witherspoon, Canada Carbide Company

New Methods of Bronze Welding—

H. M. Mattson, Lincoln Steel Company, Chicago, Ill.

W. C. Swift, American Brass Company

For the Ladies—Sight-Seeing Trip in Yellow Cab Touring Cars, leaving the Mount Royal Hotel at 10:30 A. M.

THURSDAY AFTERNOON

July 14, 1927

For the Men—For those who do not play golf—Visit to the Angus Shops of the Canadian Pacific Railroad Company, at Montreal, leaving Windsor Station at 1:30 P. M.

Golf Tournament at the Marlborough Golf Club—This tournament should be started not later than 2:00 P. M. Those intending to play can arrange to lunch at the Golf Club.

For the Ladies—Bridge Party in Salon D, Mount Royal Hotel, commencing at 3:00 P. M. Tea will be served at 5:00 P. M.

FRIDAY MORNING

July 15, 1927, 10:00 A. M. Open Meeting

Final Report Upon the Standardization of Hose Connections and Gauges—

A. J. Fausek, Chairman, Standardization Committee

Substituting Steel Plate and Structural Shapes for Iron Castings in Machine Construction—

Stuart Plumley

Showing G. P. A. Films and Discussion of Best Means to Give Them Wide Publicity—

E. D. Findlay

Plan to Furnish Information and Technical Data to Members of the Association—

Discussion of Campaign for Greater Gas Welding Publicity in the Trade Papers—

For the Ladies—Sight-seeing trip to Lachine and Lake Shore leaving the Mount Royal Hotel in motor busses at 10:30 A. M., with luncheon at Lake Shore at 12:30 P. M.

FRIDAY AFTERNOON

July 15, 1927, 2:00 P. M. Closed Meeting

Report of Nominating Committee....M. L. Goodrich, Chairman

Election of New Directors and Officers—

Trip to Shawinigan Falls

Leave Montreal on special sleepers at 5:00 P. M. via Canadian Pacific Train No. 356 from Place Viger Station.

Dinner on the dining car en route.

Arrive Shawinigan Falls 8:40 P. M. Friday evening and occupy sleepers for the night.

SATURDAY

July 16, 1927

Breakfast at the Cascade Inn. Visit Shawinigan Products Corporation's Carbide Plant. Luncheon at the Cascade Inn. Leave Shawinigan Falls at 1:40 P. M. via Canadian Pacific Train "The Frontenac." Dinner at the Mount Royal Hotel, or elsewhere as desired.

SUPPLY MEN TO HOLD CONVENTION AND EXHIBIT AT CHICAGO

The Supply Association will hold their annual convention and exhibit in conjunction with the American Railway Tool Foreman's Association, at the Hotel Sherman, Chicago, Aug. 31st, Sept. 1st and 2nd. The Convention of Association of Railway Supply men will follow, on Sept. 6th-9th inclusive. It is expected that last year's large attendance of men interested in tools, machinery, and steels will be more than doubled this year.

Arc Welded Steel Windows

Another Instance of a More Substantial Steel Structure Fabricated by the Welding Process

By C. M. Rusk*

METALLIC Arc Welding practically made its commercial debut in the railroad shops, then followed the shipyards, tank shops, and ornamental iron works. It is now branching out in the light and heavy structural shops. One of the many causes for its rapid strides into the structural field is the ornamental iron shops.

These shops took on arc welding at first only for non-strength members, such as cellar window guards, placing ornamentation

Fig. 1. One of Twenty-Eight Welded Windows. Note Size in Comparison With Door at Lower Right of Picture.

in panels of railings. The more progressive shop expanded its activities into the making of window frames and sash doors and door framing.

The A. F. Jorss Iron Works, 313 13th Street, N. W., Washington, D. C., is one of the outstanding shops of this character. They have just completed the all welded structural iron window frames for the new filtration plant for the District of Columbia. This large project required a total of twenty-eight window frames, all of 12 gauge steel construction, ranging in size from 6 feet by 10 feet to 20 feet by 27 feet. Of these there was only one of the largest size, the majority being about 14 feet by 20 feet.

When we speak of a welded window 20 feet by 27 feet, it does not impress us at first as being very large, but when we stop to realize that the average two story home is about 27 feet high and 15 feet wide and if we placed this window in front of a house of this type it would cover it from the ground to roof and the width would extend 5 feet beyond over our neighbor's property, we begin to realize that this is in the structural steel class.

There is about one ton of steel in this window. A full fillet weld was made on all joints and 45 pounds of ⅛" dia. electrode were used and it required only three days (8½ hours per day) for an operator and his helper to fit up and weld the complete window frame.

The photograph shows the window clearly, and you may compare the size with that of the doorway in the lower right hand corner. The window is constructed along the general design for this type of 12 gauge steel rolled to shape, providing for 12 transom panels and 12 fixed panels in the lower section. The lower

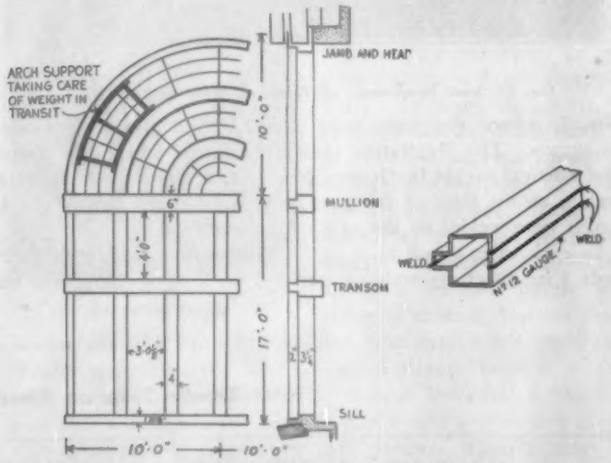


Fig. 2. Details of Construction of Welded Window.

or rectangular section is 20 feet wide and 17 feet high. The upper or semi-circular section is 20 feet wide by 10 feet high. When the plates were rolled to form the frame it was found to be a difficult job. As shown in the cross section view you will see that one of the legs of the shape is shorter than the other. This caused the short leg to bend in when being formed. This condition was overcome by arc welding. They bent the shapes with equal legs and inserted a strip to compensate for the difference in leg length.

The upper or semi-circular section was supported by welded arch braces to carry the weight of the frame and keep it in shape while in transit from the shop to the building operation and these same braces were found to be of value in placing the window as it held the frame rigid until it was encased in the brick work.

The window is exposed to the sweep of the northwest winds and to protect it from the wind pressure they extended the transom bar by the addition of channel irons into the brickwork and connected these up with the columns on both sides of the window. All of the large transom windows are operated from one control wheel located directly beneath the window and above the radiators. One of the smaller steel window frames can be seen to the right and above the large window.

The A. F. Jorss Iron Works, using a Westinghouse Arc Welder and Wanamaker Coated Electrodes, fabricated everything that is possible by the metallic arc method—door frames and doors, window frames, hand railings, gratings, stairways complete, pipe railings, hollow steel doors, scroll work for ornamentation, iron

*R. D. Thomas & Co., Philadelphia.

fence and cellar doors, fire escapes and balconies and grills. They use phosphor bronze electrodes for metallic arc welding corners and clips on their bronze door frames.

TENSILE TESTS ON WELDERS' SPECIMENS

Before putting an operator on important work, the Manchester Engineering and Welding Company, of Manchester, N. H., always have tests made of the character of his welding, and it was for this purpose that the tests shown in the illustration were made.

There was no special preparation of the joints, steel being used as it came from the shearing machine, except for Group No. 7, where the rods were pointed with the carbon arc, as shown. The illustration also gives details of the horizontal and vertical welds in Groups No. 1, 2, 5, and 6, which were welded on the sides of the strap only, and Groups Nos. 3 and 4, which were welded on the ends of the strap only.

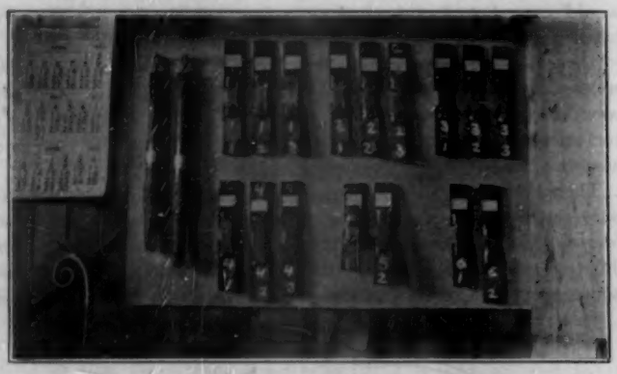
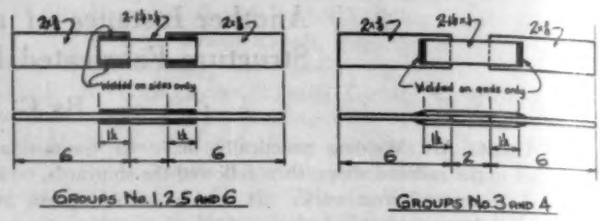
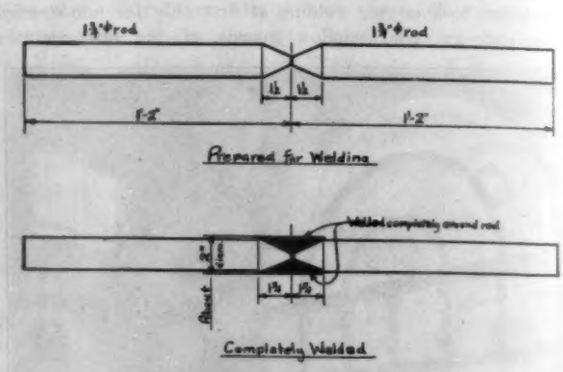


Fig. 1. Test Specimens of Work of Welding Operators.

In each case, two 2 in. x ⅜ in. bars were joined, with their ends 2 in. apart, by welding two 1¼ in. x ¼ in. bars, one on each side of the larger bars, and overlapping 1½ in. at each end

Groups Nos. 1 and 6 were tested at the New Hampshire University and Group No 7 at the Massachusetts Institute of Technology. The results of the tests are given in the table. Test pieces No. 5-1, 5-2, 6-1, 6-2, were made by an apprentice and were made to check up on how he was progressing and should not be included with the other pieces.





GROUP No. 7

Tensile Tests on Electric-Arc Welded Specimens

Group No.	Piece No.	Position of Weld	Breaking Load (Lbs.)	Avg. for group (Lbs.)	Inches of Weld	Load per in. of Weld (Lbs.)	Avg. for Group (Lbs.)	Nature of Failure
1	1	Horizontal	39,150		5¼"	7457	(No indication of	One 1¼" bar completely broken
1	2	Horizontal	41,200		5	8240	yielding in weld)	One 1¼" bar completely broken—other 1¼" bar cracked
1	3	Horizontal	39,550	39,967	5¼	7533	Great. than 7410	One 1¼" bar completely broken—other 1¼" bar cracked
2	1	Vertical	38,200		5⅜"	7107	(No indication of	One 1¼" bar completely broken
2	2	Vertical	40,750		5	8150	yielding in weld)	One 1¼" bar completely broken
2	3	Vertical	40,050	39,667	5	8010	Great. than 7422	Both 1¼" bars completely broken
3	1	Horizontal	28,750		2¼"	12778		One weld broken on center line of weld
3	2	Horizontal	25,500		2¼	10889		One weld torn away from 2" bar
3	3	Horizontal	25,500	26,583	2⅜	10737	11468	One weld torn away from 2" bar
4	1	Vertical	20,600		2⅜"	8252		One weld torn away from 1¼" bar
4	2	Vertical	15,150		2⅛	7129		One weld broken on center line of weld—another weld torn away from 1¼" bar
4	3	Vertical	18,200	17,983	2¼	8111	7831	One weld broken on center line of weld—another weld torn away from 1¼" bar
5	1	Horizontal	40,700		4¾"	8568		2 welds broken on center line of weld
5	2	Horizontal	39,800	40,250	4⅞	8164	8366	2 welds broken on center line of weld
6	1	Vertical	32,500		4½"	7222		All 4 welds on one 2" bar broken on center line of weld
6	2	Vertical	38,000	35,250	5¼	7238	7230	All 4 welds on one 2" bar broken on center line of weld
7	1	Horizontal	144,500		2" diam. 3.14sq.in.	46,019 lbs. per sq. in.	(No yielding in weld)	One rod broken 6" from center line of joint
7	2	Horizontal	148,400	146,450	2⅛" dia. 3.55sq.in.	41,803	Greater than 43,911 lbs. per sq. in.	One rod broken 8" from center line of joint

Morehead Medals Presented

International Acetylene Association Honors Edmond Fouche and Augustine Davis for Pioneer Work in Acetylene Industry

ON THE evening of June 21st the International Acetylene Association held a banquet at the Union League Club, New York City, in honor of Messrs. Augustine Davis and Edmond Fouche, and for the purpose of formally presenting to them the Morehead medal, the highest honor which it is within the power of the industry to bestow.

The Morehead medal was endowed by Mr. J. M. Morehead in honor of his father, Mr. J. T. Morehead, in whose experimental electrical furnaces calcium carbide was first discovered and produced. As announced during the 1921 convention of the I. A. A., this medal of gold and a certificate to accompany it is to be awarded from time to time for attainments in acetylene, for new discoveries and for valuable papers and addresses.

Edmond Fouché

In 1924 the medal was awarded to Edmond Fouche, of Paris, France:

"For pioneer work in making possible the safe compression of acetylene into cylinders and the perfection of oxy-acetylene blow-pipes."

In 1925 the medal was awarded to Augustine Davis:

"For pioneer work in developing low and medium pressure acetylene generators and advancing the art of oxy-acetylene welding."

Augustine Davis

Since these awards are made on the basis of the highest achievement and in view of the valuable contributions which the recipients have made to the industry, it was deemed proper to make formal presentations at a special meeting and dinner. It was attended by a large group of the most prominent men in the field of acetylene, who by their presence testified their recognition of these deserved honors.

This group represented a number of large and important industries, somewhat dependent on each other, but all of them dependent on the possibilities which exist in the application of the oxy-acetylene welding and cutting processes. The inventions which have made such developments possible have encouraged the establishment of huge plants for the production of calcium carbide plants, for the production of acetylene gas and its compression into cylinders, so that it can be safely shipped to any point, plants for the production of oxygen gas which is a companion to acetylene in nearly every operation in which it is used commercially, and plants for the production of the apparatus which is necessary for the combining of the two gases to produce the indispensable oxy-acetylene flame.

At the conclusion of the very enjoyable dinner, Mr. W. A. Slack of Chicago, president of the International Acetylene Association, called the meeting to order and outlined briefly the purpose of the evening's program. Going back to the beginning of the International Acetylene Association, he pointed out that the purpose of the organization was to get all firms in the oxy-acetylene industry together, compare notes, establish general information and generally serve to educate the public, not only on the proper methods of using carbide and acetylene, but also on the economic value of these products. He made special mention of the work which the association has done to provide proper safeguards in connection with the use of acetylene and the aggressive activity which still continues in this direction.

It was impossible for Mr. Fouche to come from Paris to New York to attend the banquet in person, so Mr. Maxime Mongendre, consul general of France, was invited to be present and receive the medal for him. The presentation of the 1924 medal and certificate was made by E. L. Davis of Cleveland. Mr. Davis said:

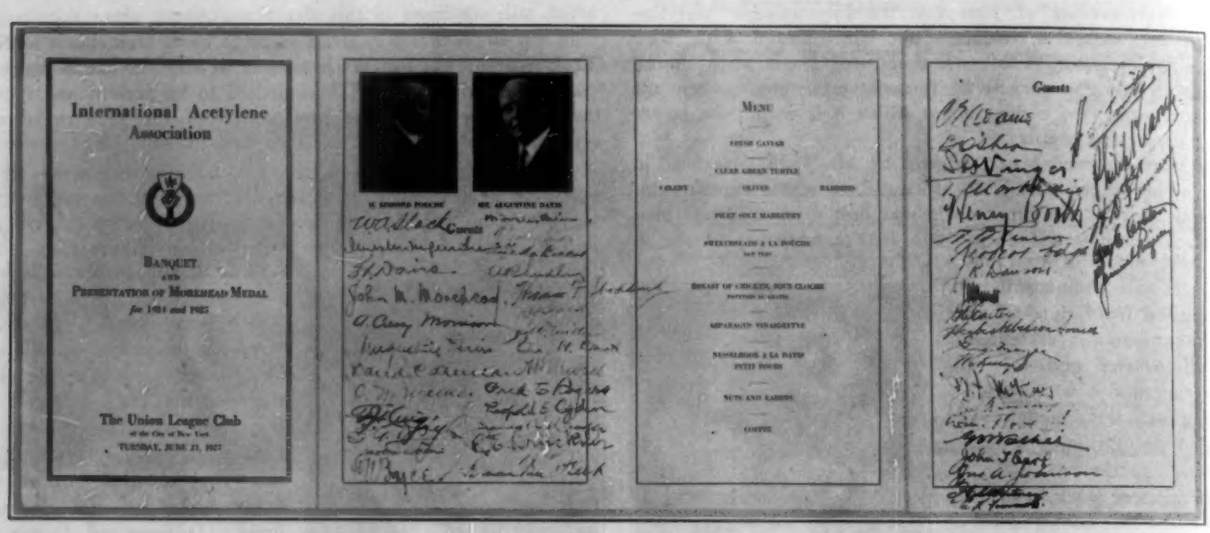
"If it were possible for us to analyze man in such a manner as to determine that quality that is within him that has the greatest bearing on his success, I think many of us would be surprised to find that it was that quality that we call imagination. The dream if you please. This is particularly true of those things which he creates. In other words, man creates or builds in accordance with the development of his imagination in accordance with his power to dream. Do not misunderstand me, the imagination or the dream alone will not create or build. It must, of course, be accompanied by other qualities or ultimate success cannot be obtained. One must also have the determination to carry on despite failures and disappointments. However, before anything is builded, before anything is created, first the imagination must be brought into play, first must come the dream. Napoleon became the first soldier of France because he pursued his dreams. Washington became immortal because he was able to imagine the benefits that would accrue to a people that were free to shape their own destiny. Lincoln takes his place among the greatest figures of all time because there was breathed into his very being, the wonderful spirit of the dreamer. The Wright Brothers had the quality of imagination in a very high degree and now man imitates the bird. Out near where I live in the town of Oberlin, there was a young man named Hall who was a dreamer. In a shed in the yard, he pursued his dream. The neighbors said he was only a dreamer, and would never amount to anything, yet from his dream came the modern process of making aluminum from bauxite ore. We could go on and illustrate indefinitely. Modern business is supposed to be a cold, prosaic sort of thing, and yet I say to you, no business was ever built that was not the fruition of some man's dream.

"I take it then, that we are gathered here tonight because in the two men to whom we do honor there was developed in a very high degree the power of imagination. The absent one with whom at the moment I am concerned, had a dream that if he could combine in a certain way the burning of two particular gases, he could produce very high temperatures which would be of great value to industry. He pursued his dream relentlessly permitting neither failure nor disappointment to deter him from accomplishing his task and gave to the world that device which we know as the Oxy-Acetylene Torch. No one can estimate the value of this invention to mankind. It has been said, and not without foundation in fact, that the last great war could not have been brought to as rapid a conclusion without the assistance of this device. As is generally the case, the development of this device had a great influence on the development of another great

business. Before the invention of the Oxy-Acetylene Torch, the oxygen business was very small. Oxygen was manufactured in negligible quantities. Since this device was given to the world, the annual quantity of oxygen manufactured runs into billions of feet.

"Another important achievement of the man we honor was to make safe the transportation and use of acetylene under pressure. He saw that it was necessary to provide for the transportation based on the use of dissolved acetylene.

"On the 12th March, 1902, the members of the Chambre Syndicale de d'Acetylene witnessed the first autogenous welding tests carried out in the laboratories of the Compagnie Francaise d'Acetylene Dissous, and, in the Revue Generale de l'Acetylene, March, 1902, appeared an article signed by Messrs. Fouché and Picard and entitled 'Oxy-acetylene Torch,' where interesting details concerning this novelty were disclosed.



Messrs. Fouché and Davis Were Given Menu Cards Autographed by all the Guests Present at the Dinner.

of one of the gases he used, so that a relatively large quantity could be transported safely in a small space. The power of imagination is again brought into play, the task again relentlessly pursued, and there is given to the world the steel cylinder filled with a porous substance and charged with acetone. As you know, acetylene is today safely transported in millions of these cylinders. The man of whom I speak had a large share in the perfection of this method of transporting acetylene.

"Too much honor cannot be accorded to one who has given to mankind the things of which I have spoken, and now, my dear sir, on behalf of the International Acetylene Association, I have the honor as well as the very great pleasure to confer through you, as the official representative of his country, upon Mr. Edmond Fouche, this Morehead Medal and this engrossed parchment in recognition of his distinguished services to the acetylene industry, and may I express the hope that this gathering may be the means of forging another link in the traditional chain of friendship that has bound together your country and mine for so many years."

The following biographical note concerning Mr. Fouché, prepared by the Office Central de l'Acetylene, tells in detail of his specific contributions to the industry.

"Mr. Edmond Fouché, old pupil of the "Ecoles Nationales des Arts et Metiers" and former student at the "Ecole Polytechnique," was born in Paris on the 6th September, 1861.

"After having acted as engineer in different industries he was in 1896 called to the management of the Compagnie Francaise de l'Acetelyne Dissous, established to work the patents of Messrs. Claude and Hesse.

"With the assistance of his collaborator, Mr. Ch. Picard, he solved the problem of the porous filler required to absorb the acetone, making it possible to safely compress acetylene into cylinders.

"Mr. Fouché's work at that time included a study of the different uses of dissolved acetylene and he was responsible for the first applications of acetylene under this form.

"It was chiefly a matter of lighting methods; he studied incandescence lighting and in this connection made a special burner which gained a certain renown at the time.

"Afterwards his attention was called to the utilization of the heat generated by mixtures of acetylene and air, acetylene and gasoline, acetylene and oxygen, and the outcome of these researches was in 1901, the first high pressure oxy-acetylene torch

"The high pressure torch could only be used on dissolved acetylene. Mr. Fouché thought that, in view of the numerous acetylene generating plants of the low pressure type which were already in use, a low pressure torch would be desirable. He therefore designed and patented the oxy-acetylene torch which bears his name (the Fouché torch). This torch gave birth to the now so important welding industry.

"Mr. Fouché was one of the first members of the Chambre Syndicale de l'Acetylene et de la Soudure Autogene, of which he was vice-president for about ten years and has been president since 1920.

"He is also president of the Association of Old Pupils of the 'Arts et Metiers' National Schools and has been for many years a member of the committee of the Society of Civil Engineers of France.

"Mr. Fouché presided the Eighth International Acetylene Congress held in Paris in December, 1923. He is also the author of the memorandums and papers submitted to the Academie des Sciences on the following subjects:—

" 'Mechanics as applied to the movements of animals and revolving bodies';

" 'Thermodynamics and the mechanics of fluids.';

" 'The theory of the distillation of fluids (the latter work brought him the award in 1921, of the Montyon Prize for Mechanics by the Academy of Science.)'

"As a member of the National Committee on Lighting, he carried out researches and issued reports on lighting, photometry, luminous projections, etc., etc.

"Mr. Fouché was nominated Chevalier de la Legion d'Honeur in April, 1926, a belated recognition of his high merits.

"He is also honorary member of the American Welding Society, and also of the British Acetylene and Welding Association. He was also awarded a few years ago, together with Mr. Claude, the medal of the U. S. Franklin Institute."

In accepting the medal in behalf of Mr. Fouché, Mr. Mongendre expressed his appreciation of the honor bestowed on his countryman. He spoke highly of the assistance received from American research in science and mechanics, and acknowledged the importance of the co-operation between the two countries, resulting in this instance in the development of a powerful modern industry. This spirit of co-operation was indicated as the best element of preparation for a prosperous future.

The honor of presenting the 1925 medal to Mr. Augustine Davis was delegated to Mr. A. Cressy Morrisson, secretary of the International Acetylene Association. Mr. Morrisson gave an interesting account of Mr. Davis' early activities in the publishing business up to the time of his first acquaintance with acetylene, which was made in Niagara Falls in 1896. Mr. Davis at that time threw himself whole-heartedly into the work of producing apparatus to use carbide and acetylene, one of his first inventions being the acetylene generator with the clockwork mechanism for feeding the carbide to water.

In 1905 Mr. Davis was made president of the International Acetylene Association. In 1906 he became associated with Mr. Bournonville and formed The Davis-Bournonville Company, the first manufacturers of medium pressure acetylene generators. He was a pioneer in the construction of acetylene generators intended for supplying gas for house lighting. He and Mr. Bournonville were responsible for the first use of the oxy-acetylene torch in the United States. In those early days the manufacture of oxygen did not reach the high state of development which is now well known to the industry. One of Mr. Davis' contributions to oxy-acetylene welding was the manufacture of an oxygen generating system using chlorate potash. A couple of years after the establishment of the Davis-Bournonville Company the first mechanically operated cutting torch was put on the market. This was the beginning of the large development of mechanically operated welding and cutting torches by Mr. Davis' company.

Mr. Davis' personal contributions to industry has twice before been recognized by the award of gold medals for his services in the field of acetylene.

Mr. Davis made grateful acknowledgment of the honor which had been bestowed upon him and took occasion to speak of the splendid co-operation which he had received, not only from his fellow workmen, but also from his competitors throughout the history of the development of the organization which bears his name.

Mr. D. C. Duncan of Duluth, Minn., vice-president of the International Acetylene Association, was introduced and presented to the members a concise summary of the present size and importance of the oxy-acetylene industry.

Mr. J. M. Morehead, who has endowed the medal in the memory of his father, was the final speaker on the program. From his long association with the industry, he was able to tell some interesting stories about the early days of the development of acetylene.

Those present at the dinner were:—

French Consul-General Maxime Mongendre, representing M. Edmond Fouche; Augustine Davis; J. M. Morehead, Union Carbide Co.; W. A. Slack, President, International Acetylene Association; David C. Duncan, Vice-President, International Acetylee Association; A. Cressy Morrisson, Secretary, International Acetylene Association; E. L. Davis, Past President, International Acetylene Association; J. A. Johnson, Past President, International Acetylene Association; John T. Earl, Past President, International Acetylene Association; R. A. Sossong, Past President, International Acetylene Association; H. Foster Bain, American Institute of Mining and Metallurgical Engineers; P. Samuel Rigney, President, Compressed Gas Manufacturers' Association; H. B. Pearson, President, Gas Products Association; Col. G. E. Carleton, Bureau of Explosives; H. E. Newell, National Fire Protection Association; George W. Booth, National Board of Fire Underwriters; C. E. Adams, Air Reduction Company; A. R. Ludlow, Air Reduction Company; H. Van Fleet, Air Reduction Company; F. C. Whitney, Air Reduction Company; Wm. Keeley, Jr., Air Reduction Company; F. E. Rogers, Air Reduction Company; B. O'Shea, Union Carbide Company; George B. Walker, Union Carbide Company; John D. Swain, Union Carbide Company; James R. Knapp, Union Carbide Company; Herbert Wilson Smith, Union Carbide Compay; L. F. Loutrel, Shawinigan Products Company; Henry Booth, Shawinigan Products Company; T. E. Markillie, United Lead Company; W. F. Barrett, Linde Air Products Company; F. J. King, Linde Air Products Company; G. O. Carter, Linde Air Products Company; J. N. Walker, Linde Air Products Company; E. A. Doyle, Linde Air Products Company; L. E. Ogden, Oxweld Acetylene Company; C. K. Bryce, Oxweld Acetylene Company; F. M. Becket, Union Carbide and Carbon Research Laboratories; J. R. Dawson, Union Carbide and Carbon Research Laboratories; S. W. Miller, Union Carbide and Carbon Research Laboratories; H. Sidney Smith, Prest-O-Lite Company; W. D. Flannery, K-G Welding Company; Philip Kearney, K-G Welding Company; R. E. Bruckner, Motometer Company; G. Mayer, Commercial Acetylene Supply Company; W. F. McKay, International Oxygen Company; E. L. French, Jersey Oxy-Acetylene Apparatus Company; T. H. Stoddard, General Welding & Equipment Company; H. S. Card, Welding Engineer; Stanley Winger, Gas Products Company; R. S. McBride, Washington, D. C.; Herbert Edge.

TENSION TESTS OF SPOT-WELDED DURALUMIN

Tension and corrosion tests of spot-welded specimens of sheet duralumin, conducted at the Naval Aircraft Factory, are described in the June Chemical and Metallurgical Engineering. Twenty-five specimens in each of four thicknesses of sheet, viz: 0.014 in., 0.029 in., 0.045 in. and, 0.063 in. were used. These were prepared from pieces 3x1 in., welded together in pairs to produce specimens 5x1 in., having one spot welded at the center of the 1 in. overlap. The welding was done on an automatic machine to produce the most uniform conditions of time, pressure and current. To concentrate the heat at the one spot, a strip of steel about 0.30 in. thick was used on each side of the duralumin to be welded, the localized heating being promoted by the fact that the steel has both a higher electrical resistance and a lower heat conductivity than the duralumin. No flux was used on any of the welds.

Close examination with a hand lens revealed the presence of cracks in the great majority and a porous condition in many of the welds, there being as many cracks in one thickness of metal as in another. The porous condition of the welds appeared to be more prevalent among those made in the thinner material and in many cases was very severe. Many of the welds made in the thicker gauges appeared to be quite sound, but the suspicion that the interiors were porous was confirmed when the fractures were examined after the tension tests.

Five specimens in each of the four thicknesses of metal were tested in the conditions as welded. The remaining twenty specimens in each group were heat treated and aged as follows before being tested: (1) Heated for 20 minutes at 500 degrees C. in a molten mixture of equal parts of sodium nitrate and potassium nitrate, followed by quenching in water at about 60 degrees F; (2) Aged at room temperature for ten days.

The third, fourth and fifth groups of five specimens in each thickness were exposed for periods of 100 hours, 30 days and 60 days, respectively, to the spray of a 20 per cent salt water solution. Up to the end of 30 days' exposure little accelerated corrosion could be detected at or near the welds. At the end of 60 days in the salt spray, however, increased corrosion was manifested in a number of specimens by the presence of a ring of pits around and concentric with the weld, about 3-32 inch therefrom. This was in all probability the result of electrolytic action between two unlike physical conditions of the metal, and indicates that localized corrosion at electric spot welds in duralumin will persist to some extent even after heat treatment and aging.

At the end of the 60 days' corrosion tests, all of the hundred specimens were tested in tension. The erratic results are construed as indicating that the welding technic has not yet been developed to the point where the strength of a welded joint of duralumin can be predicted with any degree of accuracy. Average values of the strength of joints increased, as the thickness of the sheet increased, from a breaking load of 173 pounds for the 0.014 inch sheet to 882 pounds for the 0.063 inch sheet. The rapid increase in strength with increase in thickness is accounted for by the fact that the diameter of the weld increased with the thickness of sheet, and also that, in the case of the thinner sheets, failure occurred by the weld pulling out of one of the strips, leaving a hole, while in the case of the thicker materials failure occurred as a pure shear of the weld.

In most cases, heat treatment followed by aging effected an increase in the average strength of the joints, but the results, in general, do not compare favorably with the shear value of 30,000 pounds per square inch for heat treated and aged duralumin.

The experimental work is being continued with a view to improving the quality of the welds, and it is not improbable that as a result of properly directed research the present difficulties will be overcome and that this method of joining sheet duralumin may some day compete successfully with riveting and other types of joint.

Reducing Pipe Line Stresses*

Bronze Welded Cast Iron Pipe for Gas Mains Gives Satisfactory Service When Laid With Proper Mechanical Precautions

Introduction

IN 1924 the bronze welding of cast iron pipe was first introduced in the gas distribution industry by the engineers of one of the large gas companies in California as "An Improved Method of Jointing Cast Iron Pipe." As this construction offered the ideal and leakproof joint for gas mains, several lines were laid, a number of which were, however, relatively short and principally for experimental purposes.

During the winter following installation, some of these lines broke. Statistics compiled from fifty lines in various sections of the country showed that failures amounted to less than one and a half per cent of the total of twenty thousand joints laid. Breaks seldom occurred in the bronze joints, but generally adjacent to them and sometimes further away in the body of the pipe.

The statistics, although carefully compiled, did not offer a comprehensive explanation as to the cause. The opinion of some engineers that the breakage was due to a weakening caused by structural change in the pipe during welding, was proven erroneous by extensive research. Since all breaks occurred in winter, it seems that temperature change was responsible either directly by causing the pipe to contract, or indirectly by causing ground disturbances. Analysis and experiment show that the contractive force due to probable temperature change would not by itself cause failure. It is, therefore, evident that the trouble is potentially present in any long welded line of cast iron when laid improperly and without precaution being taken to minimize the combined stresses. These stresses may increase to such an extent as to require but a small additional temperature stress to exceed the tensile strength of the pipe.

Stresses may arise from several causes. It is evident that if the separate lengths are carelessly aligned for welding, stress will immediately be present when the joined section is laid, since the chance alignment before welding cannot be reprodused in the trench. If further carelessness exists in backfilling under and around the lower half of the pipe, it is certain that at various places the pipe will be unevenly supported and will be stressed as a continuous beam carrying loads of varying earth pressures. If no provision is made to relieve the temperature stresses induced immediately after backfilling and later with seasonal temperature changes, these stresses may also be added to those previously mentioned.

By exercising proper and reasonable care, these stresses, known to exist, may be reduced. When these controllable stresses are minimized by proper welding procedure, careful laying and backfilling, then the unavoidable stresses caused by shock, settlement, and adjacent ground disturbances will have less effect and breakages in lines will be reduced to a minimum.

Purpose of Investigation

To study the problems of buried pipe lines in actual service and to determine the conditions necessary to insure a successful installation, an extensive investigation of a high pressure bronze welded cast iron pipe line was undertaken by the United States Cast Iron Pipe and Foundry Co. and The Linde Air Products Co.

To determine the effectiveness of expansion joints, various types were installed, giving section lengths varying from 82 feet to 454 feet. Observations and measurements have been or are to be made under all weather and temperature conditions. In addition, accelerated tests of temperature changes and shock are being made on the entire line. The procedure for aligning, laying and backfilling, the spacing of expansion joints, the movement of pipe in the ground, the ground friction, temperature changes and strains induced in the pipe were observed and studied in order to determine as fully as possible all the factors and problems involved.

This investigation of a bronze welded cast iron line under actual service conditions will furnish the gas distribution industry with authentic information as to the best method of laying these lines to insure a successful leakproof, long-lived installation.

General Description and Layout of Line

The main line, 1,604 feet long, is constructed of 6-inch Class 150, plain end de Lavaud centrifugally cast iron pipe and is installed at the Burlington, N. J. works of the Pipe Company. All joints in the pipe are bronze welded.

The line is buried with an average cover of 4 feet 9 inches and pitched 1½ inches per 100 feet for the first six sections and 4¾ inches per 100 feet for the last three sections.

Soil Conditions. The character of the soil for the various sections is reported in Table 1 in order that a comparison of any effect of ground conditions can be made.

Character of Soil in Which Line Was Laid

Table 1

Section No.	Description of Ground
143-foot	Gravel mixed with sand and clay, gravel and sand predominating.
450-foot	First three-quarters of section in sand and clay mixture, with occasional small quantities of gravel. Last quarter of section in slag and foundry refuse.
82-foot	Slag, cinders and foundry refuse.
200-foot	Fine sand and clay mixture with small quantities of gravel.
300-foot	First half typical river gravel with sand and small quantities of clay; last half clay and sand, with sand predominating.
400-foot	First half sand and clay, with sand predominating; last half gravel with large rocks.

Special Features and Weld Dimensions

Short flange and plain end sections are bronze welded to the line to connect with all flanged fittings. The intake end as well as each point of change of direction is anchored. The This 600 feet includes a short 143-foot section and a long cross at the intake is provided with connections to an existing 6-inch air line and, in addition, to a 2-inch steam and a 2-inch water supply line, so that accelerated tests of changes in temperature can be made. A gate valve is inserted in the line to confine the accelerated tests to the first 600 feet, if desired. This 600 feet includes a short 143-foot section and a long 454-foot section.

The main line is in actual service, carrying 100 pounds air pressure and connects compressors located in remote parts of

**Abstract of a report prepared jointly by E. Hering, Assistant Chief Engineer, United States Cast Iron Pipe and Foundry Co.; F. G. Outcalt, Field Engineer, United States Cast Iron Pipe and Foundry Co., and T. W. Greene, Engineer Development Section, Engineering Department, Linde Air Products Co.*

the plant. Approximately 1,200 feet is under the main highway of the plant and is subjected to severe traffic conditions, similar to that encountered in cities. Four hundred feet, laid approximately at right angles to the main stretch, parallels the de Lavaud foundry and is not subjected to traffic shocks, except where it crosses under an industrial railroad.

A supplementary section 120 feet in length is laid under the plant highway with about 18 inches of cover, which is typical of shallow bury in municipalities. This line will show the effect of frost in the ground combined with traffic shocks on the pipe.

The section lengths of the 1,604-foot unit are given in Table 2 (See Fig. 2).

Seven reinforced concrete and three wooden pits, designed to sustain the heavy traffic on the road, are constructed so that measurements of ground and pipe temperature, movement of the pipe and strains induced in the line can be made at any time and under any weather conditions. These are located at the ends of every section, with additional pits placed at the center and quarter points of certain sections.

Welded joints of various sizes and types were used to determine whether the weld dimensions have an important

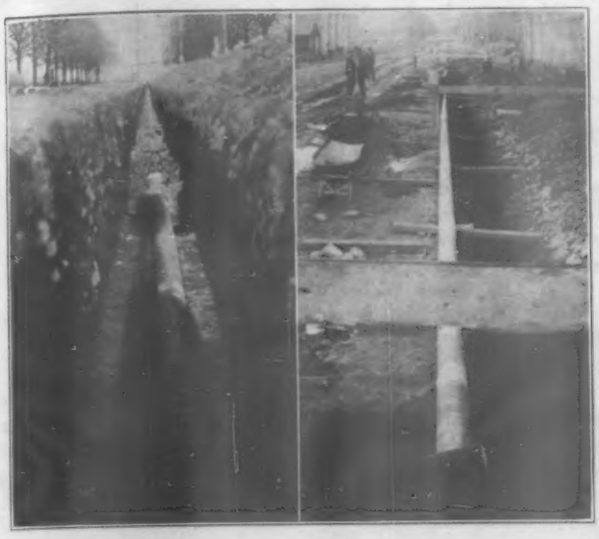


Fig. 1. Left, Backfill Tamped Solidly. Right, Welding of 143 Feet Completed. Note Batter Boards for Grading.

Table 2

Length of Section	Location of Section from Intake End
82 feet 1¼ inches	3rd section
143 feet 8 inches	1st section
198 feet 7⅝ inches	4th section
302 feet 3⅝ inches	5th section
406 feet 5 inches	2nd section
454 feet	6th section

The different types of expansion joints, their location and a brief description of their construction are given in Table 3.

Table 3

Location of Expansion Joint in Line	Type of Joint	Brief Description of Joint
At beginning of line, west end of 143-foot section	Anthony	Bell-shaped socket cast integral with pipe, to which is bolted follower ring to hold gasket around inserted cast iron plain end pipe.
Between 143-ft and 454-ft. sections	Autotite	Special slip type with movable packing automatically adjusted by pressure on self-aligning follower ring.
Between 454-ft and 82-ft. sections	Amer. Dist. Steam Jt.	Standard iron body, brass sleeve slip type expansion joint.
Between 82-ft and 198-ft. sections	Dresser	Standard dresser joint, consisting of a sleeve fitted over the ends of pipe holding in place two gaskets. Gaskets are pressed against pipe by follower rings and bolts.
Between 198-ft and 302-ft. sections	Anthony	
At end of 302-ft. section	Autotite	
Beginning last 406-ft. section	Dresser	
End of 406-ft. section	Special	Special joint constructed to function on the principle of corrugated bellows action.

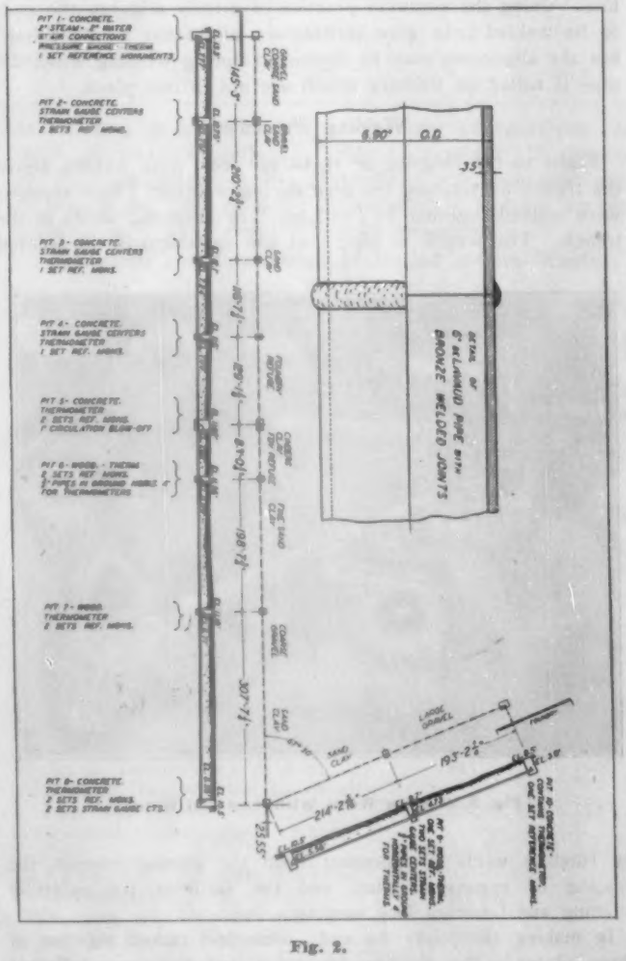


Fig. 2.

bearing on the strength of the joint or pipe. One hundred and six welds were made 1 inch wide and 3/16 inch thick. Four were made having a width of 1⅝ inches and 3/16 inch thickness. To test the strength of a small collar joint, 23 welds ⅝ inch wide by 3/16 inch thick were made on 250 feet of the last section. All these joints were collar type welds. In the last 150 feet of the last section, 15 Vee butt welds were used to test this type of joint.

The layout of the line, the depth and character of backfill, location and types of expansion joints, pits and other detail information are shown in accompanying figures and photographs.

In aligning the pipe for welding above the trench, special care was taken to insure straight jointed sections. Two timbers under each pipe for several lengths were graded by

Table 4

Types of Welds	Welded Width	Dimensions Thickness	Time	Gas Consumption Cu. Ft. Oxy.	Gas Consumption Cu. Ft. Acety.	Bronze Rod Oxweld No. 10	Oxweld Brazo Flux
Rotating standard collar	1 inch	3/16 inch	15 min.	8	7.7	7/8 lb.	1 oz.
Rotated wide weld	1 3/4 inch	3/16 inch	27 min.	14	13.4	1 1/2 lbs.	1 1/4 oz.
Rotated narrow weld	5/8 inch	3/16 inch	10 min.	7	6.7	7/16 lb.	1 oz.
Vee weld	5/8 inch	.....	14 min.	8	7.7	7/8 lb.	1 oz.

blocking to form a table for aligning the pipe and for maintaining their alignment, when rotated for welding. This was accomplished by means of a line stretched between stakes about 50 feet apart.

The alignment of the pipe, although apparently a small detail, is of utmost importance. To lay the pipe straight and free from bending stresses, it must be welded in a straight line. Using the common practice of merely aligning the ends to be welded may give satisfactory alignment for "tacking," but the alignment may be destroyed during welding when the pipe is rolled on timbers which are not in one plane.

Welding Procedure

Eight to ten lengths, or 96 to 120 feet, were welded above the trench by rotating the pipe during welding. These sections were welded together by "bell hole" or overhead welds in the trench. The length of pipe that can satisfactorily be jointed

Fig. 3. Testing Welds With Soap and Water.

by rotating welds is dependent upon the ground contour, the spacing of expansion joints and the facilities for carefully aligning and lowering long sections.

In making the joints the ends were first tacked together at three places. The welding procedure and technique followed in welding the standard collar joints was in accordance with that specified in "Procedure Control for Bronze Welding Cast Iron Pipe."* A No. 8 Oxweld welding head was used. In making the narrow dimension collar joints the same general procedure was followed, except that a smaller blowpipe head, No. 6, was used with a higher oxygen pressure of 30 pounds, and with the speed of welding increased to ten inches per minute. No special problem was offered by the Vee welds.

Testing

The welded sections were tested above the trench with 90 pounds air pressure. A four-piece clamp tightly fastened around the pipe about 6 inches from the end held bolts for fastening a face plate and rubber gasket over each open end of the pipe. This clamp is shown in one of the accompanying photographs. The line was also tested in the trench to 90 pounds after the sections had been welded together. During the air test both the pipe and joints were tested for tightness with soap and water. Only a few pin holes were found in the pipe and welds, which were easily closed by peening.

Testing Welds With Soap and Water

The average welding time and welding material used in making the different types of welds are given in Table 4.

Trench

To bring the trench to proper grade, correct elevations were established on batter boards at 50 feet intervals and usual sewer grading procedure was followed. Failure of the trenching contractor to realize the importance of proper grading caused the line to vary appreciably from grade, so that the pipe was entirely unsupported in some places for considerable distances. This condition might have caused trouble if left uncorrected. After being welded straight, *the line must be laid straight.* The more accurately the trench bottom is graded, the less work is required to dig or fill under the pipe to secure this straightness and the desirable uniform bearing.

Laying of Line

The sections welded above the trench were lowered with tripods spaced approximately 35 feet apart. Care in lowering prevented over-straining and bending. Although a string of cast iron pipe jointed by bronze welding is surprisingly flexible, it should be handled carefully.

Laying the line straight is a precaution which must be exercised. Horizontal bends in the line are readily seen and easily straightened by prying the pipe sidewise. The vertical bends are not so easily noticed, without carefully sighting along the top of the pipe. Moreover, straightening of the vertical bends may easily be neglected in hurried field construction unless the importance of this detail is fully appreciated. If the trench is not carefully graded, the pipe will have "sags" or "humps," which would leave it under dangerously high stresses, if back-filled in this condition. These bends must be straightened out by tamping dirt under or digging out beneath the pipe.

Backfilling

Backfilling, particularly the initial backfilling around the lower half of the pipe, is considered one of the most important factors in laying bronze welded cast iron pipe. In addition to being straight, the line must rest solidly and firmly on the ground at all points. The initial backfilling is best tamped with a 2 x 4 scantling. Careful backfilling and tamping should be continued until the line is uniformly supported at all points on a firm bed. The rest of the backfilling is of comparatively little consequence, as far as the pipe is concerned, and may be done by any method as long as large boulders are not allowed to fall from any considerable height onto the pipe.

The importance of laying the pipe straight and of carefully backfilling under it cannot be over-emphasized. Otherwise, the weight of backfill, traffic and other loads is sure to cause settlement and set up high bending stresses, which in themselves may not cause immediate failure, but which when supplemented by temperature stresses set up in winter may break the pipe. A very large majority, if not all, of the breaks which have occurred in bronze welded cast iron lines have undoubtedly been due to lack of precaution in backfilling around the lower portion of the pipe. Although the emphasis placed on this subject might indicate the necessity of extreme care in laying bronze welded cast iron pipe,

*Publication by The Linde Air Products Co.

Table 5
Soil Temperatures
Determined by placing thermometers at different elevations in soil 4 feet back from pit wall.

Date	Average Atmospheric Temp. Time of Observation	Remarks	Soil Temperatures			
			1 ft. 3 in. below surface	2 ft. 3 in. below surface	3 ft. 3 in. below surface	4 ft. 3 in. below surface, c. l. of pipe
December 21, 1926	40° F.	After several cold days temperature reached 10° and 14° F.	35° F. 33.8	38° F. 35.6	41° F. 37.4	42° F. 39
January 6, 1927	32° F.	Average winter weather.	33.8	34.7	37.4	39
January 11, 1927	14° F.	Cold day.				
January 28, 1927	30° F.	Day following two extremely cold days. Temperature reached 1° below zero.	33.8	35.6	37.4	39
		At Pit. No. 6				
January 12, 1927	30° F.	Previous day cold. Temperature reached 12° F.	32.5° F.	35° F.	37.4° F.	40.4° F.
January 28, 1927	30° F.	Temperature two previous days reached 1° below zero.	33	35.5	38.3	40.1

actually the cost of this work is relatively insignificant, and when results are considered, they entirely offset the small expense.

Temperature of Backfilling

The temperature of backfilling was observed, as this determines the temperature changes to which the line will be subjected and consequently the movement and stresses set up in the pipe. The average temperature of backfill for the whole line was about 45 degrees F. To approximate the conditions of laying in summer, the 120-foot section was heated to 90 degrees F. before backfilling.

Observations and Tests

Provisions were made to measure the pipe movement in concreted pits. Two short pieces of 4-inch pipe, one on each side of the line, were set in concrete in the ground and further anchored by the concrete floor slabs. The tops of these posts, which project a couple of inches above the line, were slotted to hold a brass wire stretched across the top of the pipe. Permanent reference stations were thus formed at both ends of each section and at the middle and quarter points of the longer sections, so the changes in length and movement of the sections might be observed at any time and under any conditions.

Thermometer wells were inserted in the pipe to measure the temperature of the circulating medium. Pieces of ¾-inch pipe, 4 feet long, were driven through the pit walls back along the trench at various elevations to determine the temperature of the buried pipe, the depth of the frost line and the temperature of the ground at various depths. Ground temperature observations will be made at times during the year when other measurements are taken.

Ground Temperature—Winter 1926-27

The soil temperatures at different elevations were observed throughout the winter 1926-27. Daily atmospheric temperatures were about normal for this region during the winter. Temperatures as low as one degree below zero were experiencd without snow, the coldest weather that has occurred in the last six years. The temperature of the soil adjacent to the pipe was from 39 to 41 degrees F. throughout the winter. Soil temperature three to four feet below the surface was found to be practically constant. The maximum depth of frost penetration was about 12 inches below the surface. Results of soil temperature observations are given in the Table 5.

Pipe Movement—Winter 1926-27

Measurments of pipe movement were made during the winter, the first measurements on November 15, 1926. The atmospheric temperature changes produced no measurable movement in any of the sections of the pipe during the winter.

The average temperature of the line was 39° to 41° F., and as the drop in temperature from the time of backfilling was small, no measure contraction could be expected. A drop of 10° F. would produce an end movement of only about 0.005 inch. A temperature drop of 20° F. is required to contract the pipe about ¼ inch, which was the limit of measurement.

Expansion and Contraction of Buried Bronze Welded Cast Iron Lines

Accelerated temperature shock tests were made on the line in mid-winter to determine the effect of extreme and rapid changes in temperature.

The data on a typical test of the first two sections is given in Table No. 6, and comparison is made with the calculated free expansion of a similar unrestrained section.

No movement occurred at the middle of the 450-foot section or at the quarter point pit, which is 127 feet from the free end.

It will therefore be seen that the expansion or contraction of a buried line bears no relation to that of a free and unrestrained line, and that the common formulas for calculating expansions do not apply.

Table 6
Expansion of 143 Ft. and 450 Ft. Buried Section of Bronze Welded Cast Iron Pipe
Special Test of Accelerated Temperature Change, Jan. 11, 1927

	At Inlet End	At Outlet End
143-FT. SECTION		
Original Temperature of Line	40°	40°
Maximum Temperature to which Line was Heated	130°-160° F.	122° F.
Calculated Unrestrained Expansion*	.54 in.	.43 in.
Measured Expansion (End Movement)	.413 in.	.195 in.
Per cent of Unrestrained Expansion	76%	45%
450-FT. SECTION		
Original Temperature of Line	40°	40°
Maximum Temperature to which Line was Heated	122°	98°
Calculated Unrestrained Expansion*	1.36 in.	.96 in.
Measured Expansion (End Movement)	.325 in.	.156 in.
Per cent of Unrestrained Expansion	24%	16%

	Temperature	Measured Movement
Measurements at center of 450-ft. section	110°	0
Measurements at quarter point of 450-ft. section	104°	0

**Calculated unrestrained expansion equals half section length times coefficient of expansion times average temperature change of half section.*

Spacing of Expansion Joints

In laying a long, continuous section of cast iron pipe as constructed by bronze welding, the tensile strains should be minimized as much as possible. It is obvious that the smaller the tensile stresses, the more resistant the pipe is to shock, bending and other strains that may be imposed upon the line.

The maximum tensile temperature stresses are imposed by the conditions under which most lines are laid, that is, during the summer months. When constructed in the heat of the summer day the line may be at temperatures as high as 90° F. to 120° F. and be fully extended. The temperature drop may be as much as 70° F. to 90° F. when the laid pipe is chilled in winter. Tensile stresses of very high magnitude are thus imposed if the pipe is prevented from contracting as the temperature drops.

Expansion joints are necessary to take care of the contraction and relieve the tensile stresses. They should be spaced so the tensile stress will not exceed a safe maximum value. If expansion joints are spaced relatively far apart, it can be seen that for the center section to contract as the temperature drops, it must pull long sections of pipe through the ground. As this requires a very large force, the stresses are not released throughout the center sections.

The results of expansion and contraction and the analysis of temperature strains in buried cast iron pipe lines indicate that expansion joints should be spaced approximately 100 feet apart. The maximum temperature stress imposed upon a 100-foot section is between 3,000 and 4,000 pounds per square inch, no matter how large the temperature change. This maximum stress occurs at the center and decreases at the ends to zero. A maximum stress of 3,000 to 4,000 pounds per square inch is believed to be conservative, but about as high as is permissible with safety for a cast iron pipe line where other superimposed strains from shock and bending are unknown. The nature of the construction requires that necessary precaution be taken to minimize these strains, but since they exist to some extent, the temperature strains must be controlled to a very low value so that the combined tensile stresses will not exceed safe limits.

Under favorable conditions such as laying the line when contracted and at relatively low temperatures, the temperature drop to the chilled conditions in the winter will be small, making the tensile temperature stresses small and permitting expansion joints to be spaced farther apart. Such conditions, however, are seldom encountered. Backfilling over the top of the pipe in the early part of the day while the line is contracted from the naturally cooler temperatures through the night is a precaution that sometimes can be used to reduce the temperature drop. This should be done wherever possible in order to minimize the tensile stresses.

The analysis of the spacing of expansion joints and the resultant maximum stress is based upon a value of ground friction of about 500 pounds per foot for 6 inch pipe. The ground friction for larger diameter pipe is not known. It seems reasonable to assume that the resistance increases proportionately with the surface of contact or proportionately with the circumference. As the pipe diameter increases the cross section area increases at a faster rate than the circumference of the pipe and the total temperature force overcoming friction increases at a greater rate than the friction.

Therefore it appears that the same spacing of expansion joints can be safely used for eight and ten inch diameter pipe, and that the maximum temperature stress will not exceed that in a 6 inch line.

Advantages of Close Spacing of Expansion Joints

Expansion joints are of principal value during construction as they permit sections to contract before the line is completely backfilled and thus relieve a large part of the temperature stresses. Once in the ground the temperature change of the line is not large, in fact it may be only half the extreme drop from the temperature during construction in the summer to the temperature of the line the next winter. The covering of the pipe during backfilling, under conditions often encountered, will reduce the temperature an appreciable part of the total temperature drop.

Spacing expansion joints approximately 100 feet apart, or every 8 to 10 lengths, has numerous practical advantages besides reducing the temperature stresses. It permits construction of sections that are conveniently handled and lowered in the trench, eliminates the expense and trouble of "bell hole" welds, facilitates aligning both for welding and straightening in the trench, minimizes construction equipment required and speeds the laying of the line. If welded double lengths are shipped from the manufacturer or welded at some convenient point, only three field welds are required to lay about 100 feet of pipe, and construction is further facilitated.

Temperature Shock Tests of Experimental Line and General Consideration of Strains

Four accelerated tests of changes in temperature were made on the 6 inch line. The analysis of the strains and movement of the pipe show that in the longer sections where temperature changes of over 100° F. were imposed, stresses of the magnitude of 10,000 pounds per square inch were set up in the pipe and bronze welded joints. In cooling, tensile stresses of nearly the same magnitude were induced by the line contracting and drawing back through the ground to its original length. In one of the tests, witnessed by engineers and representatives of several of the largest gas companies in the country, the line was heated for several hours at temperatures of 160° F., after which cold water was rapidly circulated and the line immediately chilled to 40° F. This test was extremely severe especially when it is considered that the stresses were reversed from compression to tension with such rapidity as to produce a severe shock. The purpose was to see if the pipe joints could be broken. Although subjected to the severe conditions and continuous traffic loads, the line has given no trouble and has been continuously in operation except when used for experimental purposes. The success of this line and its ability to resist the severe stresses imposed by the various tests is largely due, it is believed, to the fact that bending strains were minimized in construction.

Conclusion

This investigation demonstrates that bronze welded cast iron lines can be laid with complete assurance of success if necessary precautions are taken to minimize the bending and tensile strain in a long continuous section of cast iron pipe. The bending strain can be minimized through exercising a reasonable amount of care in welding, laying the section straight, and uniformly supporting the line in backfilling. The temperature stresses can be controlled and maintained within safe limits by the effective and proper spacing of expansion joints.

These conclusions are based upon laying the pipe below the frost line. Under normal conditions this can be done and preferably should be done wherever possible. Very little is definitely known of the nature, distribution or intensity of the bending strains that would be imposed by frost action. By spacing expansion joints 100 feet apart, the line is more flexible to resist this bending. Moreover, through proper and uniform support of the line as recommended, its ability to resist whatever bending action occurs is greatly increased. The frictional resistance to expansion and contraction probably becomes extremely large after freezing and as contraction is restrained, tensile temperature stresses are imposed by further decrease in temperature. This should not be serious with expansion joints effectively spaced about 100 feet apart, since the temperature stress will not exceed a maximum of around three to four thousand pounds before the ground freezes around the pipe, and the additional temperature stress imposed by freezing should not be dangerous.

Summary

The following conclusions are drawn from this investigation:

1. Since bronze welding converts the sections of pipe into a continuous tube of cast iron all tensile stresses, especially from bending and temperature, must be controlled so as not to exceed safe limits, inasmuch as they are not automatically minimized as in laying individual lengths.

2. The bending strains should be minimized by taking reasonable precautions during construction and laying, by

(a) Welding the section straight.

(b) Laying the welded sections straight in the trench, paying particular attention to straightening the vertical bends.

(c) Uniformly supporting the pipe by solidly tamping earth under and around the lower half of the pipe at all points.

3. The tensile temperature stresses can be minimized by effective and proper spacing of expansion joints. It appears that expansion joints should be spaced approximately 100 feet, or about every 8 to 10 lengths, in order that the maximum temperature stress will not exceed 3,000 to 4,000 pounds per square inch under most unfavorable temperature conditions of laying. Recommendations as to the types of expansion joints are outside the scope of this investigation. All the types used functioned satisfactorily for the particular service required in the experimental line.

4. The expansion and contraction of the pipe buried in the ground can be calculated with a reasonable degree of accuracy by the rationl formulas given in the report. Briefly, the analysis and measurements show that the end movement or expansion is very small for normal changes in temperature; that it is the same for all the longer sections; and that it is proportional to the square of the temperature change. The distance the pipe moves in the ground is proportional to the temperature change.

5. The line should preferably be laid below the frost line and with a minimum cover of two and a half to three feet. Settlement will be minimized through taking the precautions to relieve bending strains.

6. The successful laying of this line demonstrates that bronze welded cast iron pipe can be laid with reasonable assurance of success if precautions are taken which are practical and comparatively inexpensive, but which are inherently necessary with this type of construction.

BOOK REVIEWS

"Mechanical Appliances, and Novelties of Construction," by Gardner D. Hiscox, M. E., author of "Gas, Gasoline and Oil Engines," "Compressed Air," and "Mechanical Movements, Powers and Devices." The last-named volume, though covering thoroughly the fundamentals of mechanical movements, left a need for a book less general in treatment. The author has apparently met that need in very satisfactory fashion in the new volume, which is really a continuation of "Mechanical Movements." "Mechanical Appliances" is more special in scope than the first volume, inasmuch as it deals with the peculiar requirements of various arts and manufactures, and is also more detailed in its explanations. A few of the subjects treated are mechanical, steam, explosive motor, hydraulic and electric power generation and devices; motion and controlling devices; gearing and gear motion; vehicle, railway, mining and factory devices and appliances; and engineering and construction equipment. The publishers are The Norman W. Hanley Publishing Co., 2 W. 45th St., New York City. Net price, $4.00.

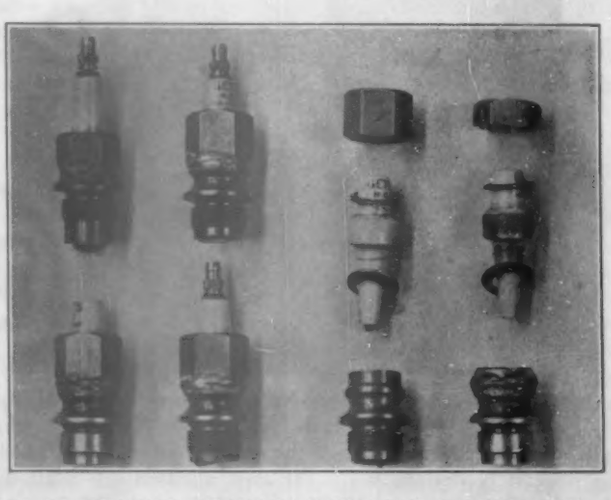
"Inventions and Patents, Their Development and Promotion," by Milton Wright, Associate Editor of the Scientific American. This book contains sound, practical advice for inventors on how to secure a patent, how to market the patent, how to raise the capital, and how to make patents pay. It discusses the relation of the inventor and his employer, the valuation of patents, advertising and publicity, trade marks, infringement, etc. This book is published by McGraw-Hill Book Co., Inc., 370 Seventh Ave., New York City. Price, $2.50.

ARC-WELDED SPARK PLUGS

By C. E. Becker*

Considerable attention is being given to the use of arc welding for manufacturing processes by various automobile companies. In most cases these applications have been made in connection with the manufacture of the automobile proper, such as the rear axle housing, torque tube, body, and frame members. In the field of automobile accessories, no extensive use of arc welding has been made but an arc-welded spark plug has now appeared.

In the past it has been the common practice to make spark plugs by assembling the outer steel shell around the porcelain core in two halves and threading these two halves together. By this method, the lower end of the upper half is threaded into the upper end of the lower part and the two halves are screwed together, tightening two copper gaskets onto the porcelain core.



At Left and Right, Arc Welded Spark Plugs in Various Stages of Manufacture. In the Center, a Plug Cut Open to Show That No Harm is Done by The Welding Operation.

Very often this tightening process injures the gaskets, thus making it necessary to take those plugs apart, put in new gaskets, and repeat the assembly.

By using a welded construction, no mechanical changes have been required and rejections due to leakage have been eliminated. The two halves of the steel shell and two copper gaskets are assembled on the porcelain core in a chuck or arbor which exerts a pressure of 60 lb. or more depending on the size and type of plug. After assembly, the plug is revolved in the special arbor for the welding operation.

In the accompanying illustration the plug on the left is shown ready for assembly by the welding process; the plug in the center is shown cut open after welding to demonstrate that no injury is caused by the heat of welding, the porcelain core being only slightly discolored; and at the right two plugs of a different style, the upper after assembly by welding and the lower the same plug after finish machining and ready for the bluing oven.

The advantages of this type of construction appear to be as follows:

No tendency to leakage due to the expansion and contraction of the shell which might cause a mechanical joint to loosen.

Fewer machine tool operations.

Materially reduced number of rejections because the assembly is done by machine instead of by hand.

For making these welds a welding current of 150 to 175 amp. is used, furnished by a single-operator welding machine of the brush-shifting type. It is understood that patent applications are pending on this method of assembling spark plugs.

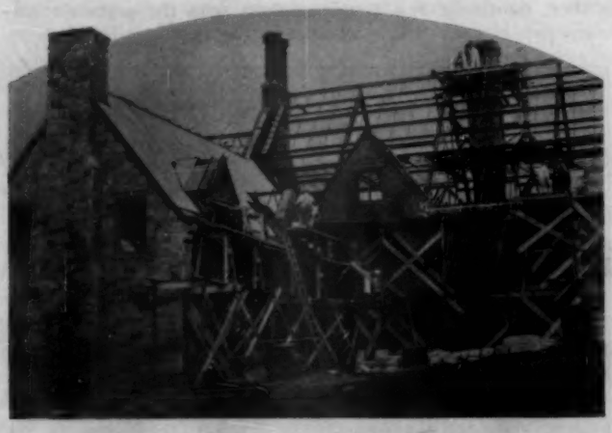
* *Industrial Department, Fort Wayne Office, General Electric Company.*

WELDING ON RESIDENTIAL BUILDINGS

With welded joints gaining more and more attention among structural engineers, it is but natural that architects are beginning to be interested in welded structural framing for the roofs of larger houses. In one attractive Long Island residence recently completed, the roofing material is so supported.

The roof consists of a foundation layer of precast cement blocks over which a ½-in. top dressing of a specially prepared plastic material is applied (by the usual method of straight-edge and trowel), this being covered with several plys of roofing felt, and lastly slate.

The application of a decking or roof to any structure using cement or similar fireproof slabs for the foundation of the exposed face, necessitates the use of light structural steel members,



General View of Welded Roof Structure.

such as angles, tees, channels, light rail or I-beams, upon which the pre-cast blocks are laid. The steel members are relatively close together because of the limiting width of the blocks, and are supported by purlins, resting upon the main roof trusses or rafters.

Light tee sections for supporting members were considered sat-

Members Carrying Weight Were Welded with Steel Rod.

isfactory by the designer of this building. These were bronze-welded to the main purlins. The old practice of bolting had presented several problems which were completely eliminated by the adoption of welding. Although the strength requirements of the tee members are relatively low, large sections were needed to give enough metal to surround bolt holes needed for attaching these to the main purlins. A welded joint at the intersection permitted much lighter members: they now need be only strong enough to carry the imposed loads. Formerly it was necessary to detail and punch the bolt holes not only in the purlins, but in all of the light roof steel. Expense and time of construction are thus high. After these factors had been studied by the contractors, the architect and the owner, they concluded that by welding instead of bolting these members, many difficulties would be eliminated.

For erecting steel on this country home, an erection crew of two or three men advanced before the welding crew. Their work consisted in pulling the steel to the roof with hand lines, cutting the pieces to proper length, placing it accurately, and temporarily attaching it to the sub-framing by small C-clamps. The welding crew then had only to make the necessary welds at the intersections.

Special bar clamps were used to hold temporarily the eave curb angles in place beyond the lowest purlin. Bronze-welding was employed for most of the work, only the most important intersections being welded with steel rod.

Bronze Welding Angles to Main Roof Members.

The roof framing of the small dormers can best be done by a separate crew. This work is of special nature, and frequently requires building false valleys, and peculiar intersections. Such a separate crew rapidly becomes sufficiently experienced in the work to operate quickly. The ordinary straight roof work offers no difficulty whatsoever.

While the application of welding to the erecting of residential buildings opens a field of no small importance, not only for the reasons given but also on account of the practical elimination of noise, examples such as this indicate some of the still greater possibilities open to designers and builders of much larger structures, such as office buildings and factories. Unbiased research has developed a strong case for the welding of structural steel joints.

TELLS OF WELDING ON LINDBERGH'S 'PLANE

The Purox Company is using a small circular which gives an interesting account of the welding on Lindbergh's machine, "The Spirit of St. Louis," which it states was done throughout with Purox apparatus and Purox gases, under the supervision of the daring young flyer himself. This interesting little folder recalls the first around-the-world flight, which was made in welded aircraft. The Purox Company was able at that time to come out with announcements that their products had been used in the fabrication of the 'round the world flying machines.

Shop Tests for Welding Rods

A Simple and Practical System for Keeping a Record of the Welding Qualities of Every Type of Filler Material Used

By P. L. Roberts*

THE issue of "The Welding Engineer" for October, 1926, contained an article entitled "Observation Testing of Filler Rod" by J. B. Green. Mr. Green emphasized the need for making tests, and though written from a manufacturer's point of view the case for such tests was not overstated. It may be interesting now to deal with the subject from a user's standpoint.

Though bare electrodes, or filling rod may be bought to specification, as far as chemical content is concerned, and some standard of quality thereby set up, this is not sufficient guarantee that the material will be satisfactory for welding. Added to this is the fact that a large percentage of covered electrodes are used for metallic arc welding, and the performance of these is entirely altered by the flux covering. Hence it is essential, if the manufacturer of welded products is to turn out high quality work at a competitive price, to test existing, and all new electrodes and rods, in order to discover the most suitable for that purpose.

Even after having decided on the most satisfactory electrode or rod for the purpose in view it is desirable to make a test on each fresh batch ordered.

Tests to determine all the facts necessary need not be very elaborate. Those outlined by Mr. Green are excellent, but perhaps rather more exhaustive than the ordinary user would care to employ particularly as they are almost entirely confined to observation tests and any metallurgical or mechanical tests would be additional.

It is intended to outline a method of making and recording tests on electrodes and rods for use in the welding of tanks and similar low pressure vessels.

The Metallic Arc

A specimen report sheet is shown in Report No. 1. A right angle butt joint in ⅜" plate is used for all three observation tests. The same generator is used on every occasion. The description of the electrode in the report sheet is brief, but is a useful check on any subsequent external changes made in the electrode.

Under the heading of manipulation is a careful description of the appearance of the molten metal and slag, and the manner in which both behave during deposition. It is obvious that this depends entirely on the Welder's skill, judgment and ability to translate into words what he observes whilst welding. For this reason a technical man, skilled in the art of welding is employed to make these tests. Further to eliminate variation in the results reported the same man makes all tests, enhancing the comparative value of the tests. The better to enable such comparisons to be made an electrode of high quality is used as a standard and the properties of other electrodes compared with it.

The heating value of the arc is proportional to the square of the current, but the amount of heat required to melt various makes of electrodes of the same size, varied with certain conditions, such as the amount and chemical composition of the flux, etc. Although the amount of variation in the current required on this account is only approximately 10% it might be of consideration in the cost of the electrical power in some cases, and certainly is an indication of the fluidity of the electrode under deposition. Similarly the length of the deposit for a given length of electrode is important as indicating the tendency to "pile" or flatten, and influencing greatly the economical considerations.

A note on the degree of ease with which the slag is scaled off is important, as scaling is a considerable factor in the labor charges. Then the finish and general appearance of a weld varies considerably with the type of electrode used; and the neatness of the weld is often an important factor in the sale of welded products. Furthermore much information can be gained, from the visual inspection of a weld, as to its homogeneity, mechanical properties, etc.

The external inspection of the deposited metal can be verified and enlarged upon by making a visual examination of a number of cross sections through the weld. These are best made by sawing through the test pieces from the edges and continuing till the test piece is severed except for the weld; then the weld is *broken* through. The structure of the deposited metal is clearly visible to the naked eye, obviating the necessity of polishing and etching.

A microscopical examination may be taken with advantage in some cases, and a space on the report may be reserved for this, but generally it is not essential.

Where the work to be welded demands high tensile strength, or other high mechanical properties, suitable test pieces must be made to determine whether the electrodes will give the results required. It is desirable in all cases, when trying out a new electrode that some mechanical tests shall be taken, which correspond to the kind of stresses developed in the products welded when under working conditions.

Oxy-Acetylene Welding Rods

A report for these filling rods is shown, but this differs only in detail so does not require much explanation.

All tests are made on right angle butt joints in mild steel sheet 0.048" thick. The same type and make of blow pipe is used for each test.

While the scheme outlined may be applied to the testing of welding material for any class of work, it is evident that adaptation must be made to suit various types of product. For instance, the type of joint and thickness of metal would be made to represent actual conditions. Mechanical tests should be devised to introduce in the test pieces the actual stresses, or an approximation to the actual stresses, set up under working conditions.

REPORT NO. 1—ELECTRODE

Description:

Heavily wrapped with two parallel strings of blue asbestos yarn. Has a fine aluminum wire running parallel with the steel core.

Manipulation:

The easiest electrode to deposit as yet known. The molten metal and slag are very fluid and very good penetration is obtained. The slag is light and floats readily, covering the deposit in an even layer, but thicker at the edges. The electrode must be connected to the positive pole of the supply.

Rate of Deposition:

No. 10 S. W. G. electrode using 90 amps., 0.83 ft. of electrode per minute is the equivalent rate of deposition at 100 amps. 0.18 ft. run of weld metal deposited per minute is the equivalent rate of deposition at 100 amps.

*Metropolitan Vickers Co., Manchester, England

Surface Appearance:
Heavy even layer of slag which chips off very readily when cold. The deposit has a fine wave form with small re-entrant angle with the plate. Fusion line is deep, varying in depth with fusing current, but always lies below the surface of the parent metal. The deposit is flat and neat.

Deposited Metal:

a) By Visual and Microscopic Examination

Sound homogeneous metal. No sign of oxidation. Always a small number of pin head slag inclusions in reinforced welds. Penetration on normal current value about ⅛ inch. Fusion can be seen readily in polished specimens, but is intercrystalline in nature.

b) By Mechanical Examination

Yield Point	Ultimate Tensile Strength	Elongation	Reduction in Area
Tons/sq. in.	Tons/sq. in.	Per Cent	Per Cent
23.05	29.7	17.0	25.0
17.0	24.2	13.0	18.6

Recommendations:
This electrode is entirely satisfactory for the welding of any mild steel work.

REPORT NO. 2—FILLING ROD

Description:
Soft iron wire. Close annealed.

Manipulation:
Melts uniformly under neutral flame. Metal is fluid, and being free from scale very little slag is formed on the surface of the pool. Easy to use, no sparking or spluttering.

Rate of Deposition:
Filling rod 0.036 inch in diameter, using 1.3 cu. ft. of oxygen and 1.25 cu. ft. of acetylene per hour. Injector, low pressure blow pipe, adjusted for neutral flame. 0.4 ft. of rod per minute. 0.4 ft. run of weld metal deposited per minute.

Surface Appearance:
Very thin uniform scale, which does not require cleaning off for most purposes. The deposit has a fine wave form, and lies flat. Fusion with the plate is excellent. General appearance very neat.

Deposited Metal:

a) By Visual and Microscopic Examination

Homogeneous metal. No inclusions or segregation of any sort. Free from blow holes. Fusion with original metal, almost imperceptible.

b) By Mechanical Examination

Recommendations:
This filling rod is suitable for the welding of any sheet steel products.

USE ELECTRIC WELDING PROCESS TO STRENGTHEN STEEL BRIDGE

When it was found that the Chicago Great Western's 1100-foot bridge over the Missouri river at Leavenworth, Kans., was not equal to the traffic demands of the division it served, several plans for strengthening were considered. Rebuilding of the superstructure was out of the question on account of the prohibitive cost. A careful analysis of the old spans was carried out to ascertain whether it would be practicable to strengthen the bridge so as to permit the safe operation of locomotives heavy enough to draw the increasing traffic. Of the plans submitted, one described in the Railway Age, calling for reinforcement of old members by welding new plates and angles to them was decided upon as being by far the most practicable.

The surfaces of the old members were carefully cleared of rust and paint before applying the new plates, which were carefully clamped in place before commencing the welding. Three-eighths inch bead welds were used, using weld material having a tensile strength of 50,000 to 60,000 lb. per sq. in. The welds were fused deeply into the base metal. Tests of field welds all resulted in failure outside of the welds.

Twenty-in. by ½-in. plates on the end posts and top chords of the two 330-foot spans, a 10-in. by 9/16-in. cover plate for the top flange, and a 14-in. by ⅜-in. cover plate for the bottom flanges of the stringers were all secured in place by bead welding along the edges. On the chord members these welds were continuous. On the floor beams the weld was continuous for 2 ft. from the ends and on the stringers 2 ft. 6 in. from the ends, with welds 1½-in. long at spacings ranging from 4-in. to 6-in. center to center for the remaining length of these plates. In addition to the bead welding, the cover plates on the chords were stitch welded along the longtiudinal center line through 15/16-in. holes punched and reamed in these plates at a spacing of 12 in. center to center.

To insure that the new material would be subjected to live load stress, the plates were welded at each end first. That this proved effective was clearly shown, for in the case of plates on compression chords or flanges the shortening of the members under live load caused the plates on which the welding had not been completed to buckle within the limits of the unattached portion.

As this was the first work of its kind, few welders were available who were accustomed to working on bridges. Consequently, a greater number of welders were employed for various lengths of service than would normally be the case. Some of the welders proved especially proficient, however, and completed from 80 to 200 feet of welds per day, depending upon how continuously they could be employed under existing circumstances. An average of 20 men were engaged on the work, which was started on February 25 and completed on April 28. Four welding machines were used, of which two were 350-400 amp. capacity A. C. machines made by the Electric Arc Cutting and Welding Company and the others were single operator D. C. outfits made by the Westinghouse Electric and Manufacturing Company.

In all, about 60 tons of cover plates and other reinforcing metal was welded in place. About 7500 lin. ft. of weld was made for which 1950 lb. of welding steel was used. The entire job was completed without interruption to train service.

With reference to this bridge, the Railway Age comments editorially:

"The work on the Leavenworth bridge was confined to increasing the section of flanges and chords. * * * There are, however, other sources of weakness in steel bridges which could well be subject to experimental application of the welding process, as, for example, the inadequate riveting of flanges. It would be of interest to ascertain whether the bead welding of flange angles to the web could serve as an effective means of supplementing the flange rivets. The railways have such an enormous investment in steel bridges built for lighter loadings than those now prevailing that any method designed to increase the facility with which such structures may be strengthened offers enormous opportunities for constructive economies."

Similar work has been carried out on several old iron and steel bridges on Australian railways to carry the weight of increased traffic. One plate girder bridge of 27 spans 48 to 112 ft. long requires increase of flange section of the floorbeams and strengthening of web splices, reinforcement of the stringer connections and similar detail work. In this case the strengthening of the floor beams was done by welding a flange plate onto the top flange which had countersunk rivets, and welding on two 3x3x½-in. angles to the bottom flange.

RECORD SPEED IN ERECTION OF WELDED WATER GAS MACHINE

The Semet-Solvay Engineering Corporation has just completed the construction of a complete Steere water gas machine in exactly 31 days from the signing of the contract with the Wisconsin Gas and Electric Company for its plant in Waukesha, Wis. This is a record for the gas industry.

The shells for the generator, carburetor, and superheater and practically all of the standard parts of a water gas machine, such as doors, various supports, piping for steam, gas, water, oil, and air left the plant at Owosso, Mich. on May 21. The shells were in place and the brick lining and checkerbricking begun by June 1. Meanwhile, all drawings and specifications were delivered between the company offices, shops, and construction staff by air mail.

Besides the main units of the machine, the piping for the backrun, foul main, grasshopper connection and erection of stairs, railings and other items of construction were all welded, giving uniform strength and neatness to the equipment.

Gas was made and the machine went into regular operation on June 16, 19 days ahead of schedule.

STRONGER, LIGHTER TOOLS MADE UP BY WELDING

In the *American Machinist* for June 2, Arthur A. Merry describes how material savings have been effected in the cost of tools in his toolroom since they started to build them of steel sections welded together.

"The welding machine was purchased primarily for use in the manufacturing department, but its possibilities in the way of economical construction was soon recognized throughout the entire plant, particularly in the toolroom. Not only is the time of the patternmaker saved, but there is no delay because of waiting for castings from the foundry. Instead of paying eight or ten cents per pound for castings, we use steel at three or four cents, to say nothing of steel from the scrap pile at no calculable cost.

"Tools made by this method are stronger as well as lighter and can be made to embody features not practicable to secure when made from castings. For instance: it is desired to place a screw in a position that would be impossible to reach in the casting for the purpose of drilling and tapping; with this method of construction we have only to drill and tap a piece of steel of suitable shape and then weld it in place.

"Square holes to locate and hold toolbits in a boring bar, difficult to make by the usual methods, are very easy when welding is available. Simply mill a slot diametrically across the end of the bar, weld in a piece of steel to close the slot, grind off the flash and you have a square hole. If the toolbit is to be held with a wedge instead of a setscrew, mill the bottom of the slot to the desired angle before welding in the piece.

"The testing machine was originally provided with a crank for turning the elevating screw of the table. The crank was rather awkward to use and we substituted the handwheel, which we made from cold-rolled steel in two hours.

"Repairs to and alterations upon tools are easy to make, since broken tools can be welded without appreciable distortion, and if it is found after a tool has been placed in service that a boss here or a lug there would be advantageous, it can be added without trouble or delay.

"A pot chuck was wanted in a hurry, and it was in use the same day. Had we been obliged to wait for a casting there would have been a delay of at least two days before we could really have started to make the tool. From our experience we have found the arc welder has effected the greatest saving of any method in building tools and we would hardly know how to get along without it."

E. H. EWERTZ OPENS CONSULTING ENGINEERING OFFICE

Mr. E. H. Ewertz, one of the founders of the American Welding Society and a past president, has left his position as general manager of the Moore Plant of the Bethlehem Shipbuilding Corporation to open up independent consulting engineering offices at 50 Church Street.

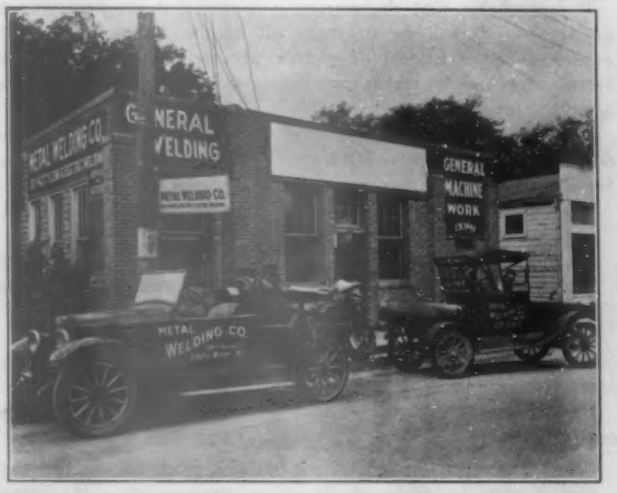
Mr. Ewertz, for a number of years, has recognized the possibilities of welding and has been one of the most enthusiastic supporters of welding, and in his new work will make a specialty of the applications of and proper use of welding in manufacturing, general engineering and structural work. In this capacity, he will be able to bring to bear his wide engineering and management experience in the solution of problems requiring a study from the point of view of utilizing welding and proper management in the reduction of cost of products, improvement of quality and the adaptation of other manufacturing methods.

Mr. Ewertz has had thirty years' experience in the engineering field including management of plants employing 9,000 men. Among the companies with which he has been connected may be included the navy yard in Sweden, Schwartzcoph Machinery Co., Berlin, Germany; Gardner & Coe, New York; Roach Shipbuilding Co.; Chester Crescent Shipbuilding Co., Elizabeth; U. S. Shipbuilding Co., Elizabeth; Victor Metals Company, the Fore River Shipbuilding Company, Bethlehem Shipbuilding Company, Bethlehem Steel Company, Electrical Boat Company. This experience in addition to shipbuilding covers construction and design of machinery and parts and the organization of one of the most sucessful war fabrication plants.

SPEED AND SERVICE BUILT THIS BUSINESS

The photograph shows the welding business of W. L. Whitlock, San Antonio, Texas.

A pioneer of the welding game, Mr. Whitlock came to San Antonio about two years ago from Ardmore, Oklahoma. At the time of his arrival, things were not breaking so good in the welding business, and Mr. Whitlock's financial status was far from being encouraging, to say the least. The only available opportunity for a start in the Alamo city, was a run down shop which was on its last legs. According to Mr. Whitlock, it was the last straw and he eagerly grasped it. The arrangement was



Ready For a Rush Call.

made on a stringent basis. Within three months he bought out his partner and, today, the Metal Welding Company handles the major portion of the welding business in the city.

The shop specializes on boiler, tank and sheet-iron work, and the business has been developed through the use of modern equipment, speedy and skillful service. As shown in the photograph, a portable arc machine, designed and built by the shop, takes care of most of the jobs.

The portable outfit consists of an old model Stearns-Knight touring car, upon which is mounted a U. S. L. 200 Ampere-60/20 generator. The platform is designed to allow for use of the car's regular top for covering the machine. Power is conveyed through the motor to a line-shaft pulley on the propeller shaft. The pulley shaft is 24 inches in length and suspended by ball-bearings. A special flange fitting with thumb screws allows for quick disconnection from the differential. The generator is belt driven; and the total weight of the complete outfit is 1,100 lbs. The car is able to travel with its load at a high rate of speed, economically, and can be set up ready for action in less thn five minutes.

CRAFTSWELD ISSUES NEW CATALOG

Craftsweld Equipment Corporation have issued a very complete sixteen-page catalog of their oxy-acetylene welding and cutting equipment. The catalog also includes several pages of general instructions on installations, dismantling, welding and cutting procedure and data.

SUGGESTIONS TO COMPETITORS IN THE LINCOLN ARC WELDING PRIZE FOR 1927

As a guide to competitors in the Lincoln Arc Welding Prize for 1927, consisting of $17,500, given by the Lincoln Electric Company of Cleveland, Ohio, and administered by the American Society of Mechanical Engineers, 29 West 39th Street, New York City, the donors have expressed the following suggestions:

Practicable, workable ideas will get more consideration than ideas in which the practicability is open to question. The problem is to develop or extend the field of usefulness of electric arc welding and make material and labor saving by its use. Certain principles have been established and no one at present can realize the economic and cultural benefits which may be obtained for mankind by the further application of the known facts. The object of each entrant should be to make concrete and practical application of the known facts and principles. The application should preferably be made in the field in which the entrant is at present engaged, so that accumulated knowledge in that field will be available and that the chance of the suggestion being impractical will be reduced to the absolute minimum.

It is probable that the entrant will find that the best way to go at the job will be to study all of the technical literature available on the subject of electric arc welding, then apply the facts and principles to his own business or branch of engineering activity.

To simplify the effort required to understand what has been done with electric arc welding up to the present time, the classification given below may be profitably considered.

(1) Welding in place of riveting on structural steel shapes and on hot-rolled plate.

(2) Replacement of gray iron, malleable, and steel castings with welded steel equivalent, built up from hot-rolled steel plates and shapes.

(3) Welding of non-ferrous metals.

(4) Welding for maintenance and repair of existing machinery, equipment and structures made of metal.

Under Classification No. 1, the following principles should be considered:

(a) The great utility of the welded joint lies in the fact that it may be made as strong or stronger than the pieces joined.

(b) The welded joint may be made permanently solid and tight, in contrast to riveted joints, in which the rivets work loose, thereby destroying the rigidity and tightness of the joint. Entrants in this contest may find applications of these principles in many pdaces, of which the following are merely a few examples:

Steam Boilers	Road Building Machinery
Pressure Tanks	Steel Freight Cars
Oil Stills	Tank Cars
Air Receivers	Bridges and Viaducts
Steel Smoke Stacks	Steel Building Structures
Steel Pipe	Shipbuilding
Structural Steel for buildings	Gear Cases, Covers and Containers used in Machinery
Steel for home building	
Automobile and Truck Frames	Vats and Chemical Apparatus

In Classification No. 2, certain facts are the basis for the use of welded steel to replace castings:

(a) Hot-rolled steel is approximately five times as strong in tension as cast iron, and two and one-half times as rigid for the same section.

(b) Thus only one-fifth the weight of steel is required to give the same strength as may be obtained in cast iron.

(c) Only 40 per cent of the weight in steel is required to give the same rigidity.

(d) Hot-rolled steel costs approximately 2 cents per pound (mill base price), against an average cost of about 6 cents per pound for gray iron castings.

(e) Considering material cost only, steel costs one-fifteenth as much as cast iron for the same strength and 13.3 per cent as much for the same rigidity.

(f) Similar ratios may be calculated for replacing malleable and steel castings with hot-rolled steel.

(g) The cost of fabricating hot-rolled steel into the equivalent of a casting is a variable factor, depending on the resourcefulness of the designer, but a great deal of work has been done at a fabrication cost of 1 cent or less per pound on the steel used.

(h) Owing to the lighter weight of welded steel construction, as compared with castings, additional economic advantages are obtained in many cases, which are more important than reduction in cost of manufacture.

(i) The fact that steel will bend before it will break gives it advantages over the use of casting in many cases.

The following simple rule-of-thumb methods will enable the entrant to make a start on re-design from gray iron castings to welded steel construction.

FOR PARTS WHERE RIGIDITY IS THE DETERMINING FACTOR.

1. Build the welded steel equivalent to the castings with the same outline dimensions but with only one-half the thickness of section.

FOR PARTS WHERE STRENGTH IS THE DETERMINING FACTOR AND RIGIDITY OF SECONDARY OR NO IMPORTANCE.

1. Where strength alone is the determining factor, make the steel section one-fourth the thickness of the cast iron section.

2. Where strength is the important factor, but rigidity a secondary consideration, make the steel sections one-third the thickness of the cast iron section.

Among the well known machines to which these principles may be applied are the following examples:

Lathes	Air Compressors
Drill Presses	Fans and Blowers
Milling Machines	Rubber Mill Machinery
Boring Mills	Paper Mill Machinery
Automatic Screw Machines	Textile Mill Machinery
Grinding Machines	Elevator Engines
Electrical Machinery	Stationary Gas Engines
Crushers	Diesel Engines
Attrition Mills	Turbo Alternators
Pumps	Laundry Machinery

The principles of application of electric arc welding described in the preceding discussion are applicable not only to steel, but also to the non-ferrous alloys. The rapidity with which new alloys are being developed and made useful to the industry makes this field of electric arc welding very important. Some work has been done. For instance, Stellite may be welded to common steel stock, thus producing the effect of a diamond-pointed tool. Great savings are effected by this method.

It is now technically possible to weld aluminum, and it appears reasonable to assume that the application may be carried into the aluminum alloys, such as Lynite and Duralumin. In the case of the latter alloy, it is only necessary to point out that the frame of the giant Los Angeles is made of Duralumin riveted together, to indicate the possibilities of weight saving by welding. A weight reduction of possibly 30 per cent in the frame of the dirigible might be expected if practical welding methods may be devised.

Many automotive engineers feel that aluminum alloys would find a wide field of usefulness in the building of an automobile if the cost might be reduced. Reduction in weight for a given strength by use of welding may be the key which will unlock this vast field of possibilities.

In welding for maintenance and repair of existing machinery, equipment and structures made of metal, the following fundamental laws should be borne in mind:

(a) The great localization of the heat of the welding arc permits welding to be done with a minimum of heat disturbance to the adjacent material.

(b) The electrical energy converted into heat by the welding arc appears in the metals being welded. The thermal effi-

ciency of the arc, as a source of welding heat, is very high for this reason, and the heat cost of operation low.

The winners of the Lincoln Arc Welding Prize for 1927 will be largely selected on the basis of amount of economic saving that the suggestion submitted shows either directly on the design submitted or in its possible wider application. All suggestions should be made with that in mind.

The Lincoln Electric Company stands ready to assist anyone by suggestions or data upon receipt, and further information can be secured from either the Lincoln Electric Company or from the American Society of Mechanical Engineers.

C. G. M. A. COMBINES BUSINESS AND SPORTS AT SUCCESSFUL SUMMER OUTING

The Compressed Gas Manufacturers' Association at their summer Outing held at the Seaview Golf Club, Absecon, N. J., from June 16th to 18th, combined a most successful business session with the sports and recreational activities offered at that Club. At the meeting, which consumed the entire evening of the 16th, Major J. C. Minor, President, presided. The members were urged to maintain the high ethical standards that exist in the industry, to appreciate the value of mutual interchange of technical information, and to continue and extend their activities in improving certain phases of the work in progress. Stress was laid upon the importance of developing lighter and cheaper packages without altering standards of strength and efficiency and the progress already made in the research along this line was briefly outlined. It was recommended that a handbook of technical data used in the compressed gas industry be published by the Association, that standard cost accounting methods, particularly with reference to depreciation, be developed by the Association and that standardized practices in handling transportation equipment be formulated and made effective.

Mr. Franklin R. Fetherston was elected as Secretary-Treasurer to succeed Mr. John H. Luening, who is to be associated with the Kentucky Oxygen-Hydrogen Company of Louisville, Ky. Mr. Fetherston has acted as engineer with the North Jersey District Water Supply Commission, and was previously associated with the chemical industry as works manager of the New Jersey Concentrating Co. and the New Jersey Metal Salts Company.

A golf tournament extending over the two remaining days of the outing gave the members of the Association the opportunity of contesting for several prizes awarded by the Association.

The cup donated by the President to the player having total low gross score was won by W. W. Robertson of Armour Ammonia Works.

In an interesting elimination tennis tournament Mr. E. C. Turner of the Air Reduction Company succeeded in defeating Mr. H. L. Cook of the Liquid Carbonic Company in the hard-fought finals, 6—4, 8—6.

The following gentlemen attended the outing:

F. S. Austin, Carbo-Oxygen Company of America; H. W. Bates, Pittsburgh Testing Laboratory; R. D. Brooks, Worthington Pump & Machinery Co.; L. A. Belding, American Welding Co.; Henry Bower, Hy. Bower Chemical Mfg. Co.; L. Campbell, Harris Calorific Co.; Col. G. E. Carleton, Bureau of Explosives; G. O. Carlson, Wm. Wharton Jr. & Co.; G. O. Carter, Linde Air Products Co.; H. W. Cole, General Carbonic Company; H. L. Cook, Liquid Carbonic Co.; J. J. Crowe, Air Reduction Co.; R. P. Davidson, Compressed Carbonic Co.; R. P. Dieckelman, Pressed Steel Tank Co.; E. A. Doyle, Prest-O-Lite Co., Inc.; J. Eldridge, Virginia Smelting Co.; C. D'W. Gibson, Air Reduction Co.; C. L. Gulick; E. A. Hale, Liquid Carbonic Co.; A. E. Hecker, Mathieson Alkali Works, Inc.; L. W. Hench, American Oxygen Service Co.; Elon Hooker, Hooker Electrochemical Co.; H. M. Hooker, Hooker Electrochemical Co.; L. A. Hull, National Carbide Co.; S. W. Jacobs, Electro Bleaching Gas Co.; F. A. Johnston, S. S. White Dental Mfg. Co.; W. C. Keeley, National Carbide Co.; J. A. Kienle, Mathieson Alkali Works, Inc.; S. B. Kirk, Union Carbide Sales Co.; W. F. McKay, International Oxygen Co.; H. M. Mabey, Mathieson Alkali Works, Inc.; J. C. Minor, Lieber Minor Co.; W. W. Robertson, Armour Ammonia Works; P. Samuel Rigney, Roessler & Hasslacher Chemical Co.; E. Rowland, Hy. Bower Chemical Mfg. Co.; Wm. Schoenthaler, Air Reduction Company; H. W. Smead, Compressed Carbonic Co.; R. A. Sossong, Air Reduction Co.; Geo. Schmidt, Linde Air Products Co.; C. C. Trees, Carbo Oxygen Co. of America; E. C. Turner, Air Reduction Co.; H. F. Reynolds, Wm. B. Scaife & Sons; R. J. Quinn, Mathieson Alkali Works, Inc.

WELDING AND VOCATIONAL REHABILITATION

By R. K. Randall

John Aubel Kratz, Chief of the Rehabilitation Division, Federal Board of Vocational Education, Washington, D. C., says: "In business as in industry, work is either so highly distributed that little or no initial training is required of the worker, or so highly specialized that pre-training is required."

Again, "When a man or woman has been thrown out of employment because of injury or disease the pressure of the need of making a living is by far the most urgent factor demanding prompt return to employment. If it is necessary to train the applicant for rehabilitation it must be done in the shortest possible time consistent with thoroughness and completeness."

Again, "Such flexibility of training arrangements makes the private business school not only very popular but actually a necessity in commercial vocational rehabilitation."

Vocational rehabilitation is a comparatively new field. Summing it up in a broad way, it means that when a worker receives an injury of such a nature that following up the line

A One-Armed Skilled Welder.

of work in which he has been engaged becomes impossible due to that injury, he is entitled and society as a whole is benefitted by teaching him some occupation so that he may support himself and his family in such a way that there is no danger of him or them becoming public charges.

The movement has two great incentives, one humanitarian, the other economic. Welding, both Oxy-acetylene and Electric processes, lends itself admirably to this training program. Let us take the case of a steel mill worker who unfortunately loses a leg, thereby becoming permanently inactive as far as the active duties of walking and climbing are concerned. This man, trained to do welding work, can very nicely fit into the factory where bench welding is performed.

Let us take the case of the numbers of men who lose hands and forearms in punch presses. These men are mentally bright and sure-footed, their handicap being the loss of either a right or left arm, part or in full. The artificial limb industry has developed steel hands by which a man may become so skillful with the use of his hook that he can readily pick a match or a coin out of his pocket. One of the men shown in the accompanying picture can take a pencil and write quite as readily with it as the average person does with his pencil in his own five fingers. The thought of a one-arm welder at first may seem ridiculous, but the skill attained by some of these one-armed men is nothing short of marvelous, not only in speed but in welds that are superior in quality.

There is, of course, a phase of psychology which helps them. They are conscious of the fact that working under the handicap which they are, their work is liable to be criticized

and inspected more closely than that which is done by their more fortunate fellow man with two good hands.

The first one-armed welder that I knew about was trained in Cleveland, Ohio, six years ago, and is today employed by a nationally known firm which makes automobile bodies. This man today stands out from among all the welders they employ, as being the speediest welder they have. He probably averages $10 a day piece work.

While boiler work, shipyard work, and structural steel work should be a closed field to this type of man, owing to the dangers involved, anyone interested in civilian rehabilitation work should give the Oxy-Acetylene and electric welding field consideration in their rehabilitation training program.

DETROIT AUTOMOBILE PLANTS OPEN TO A. S. S. T. AND A. W. S. CONVENTION VISITORS

Thousands of steel men from factories all over the world will pour into Detroit the week of September 19th, attracted there not only by the National Steel and Machine Tool Exposition and the Conventions of four technical societies, but even more by the opportunity to visit Detroit's many metal working plants.

A large amount of the steel produced in this country goes into the manufacture of automobiles and no small percentage of that is handled by the Detroit plants . For that reason, every authority on steel will be interested in studying the processes and methods in use there.

According to W. H. Eisenman, Secretary of the American Society for Steel Treating, Ford, Cadillac, Chevrolet and Packard factories already have agreed to open their doors wide for the visiting engineers and executives of the steel world. They will treat them not as casual visitors in their plants, but as students, allowing them the privilege of studying any department, organization, process, or other angle that interests them.

Besides the display of actual equipment under working conditions in Convention Hall, the theoretical and research side of the industry will be discussed at length in technical sessions of four societies interested in the metal industry.

According to the latest advice, 300 exhibitors will demonstrate the newest in factory equipment at the National Steel and Machine Tool Exposition. Altogether, some 90,000 square feet of exhibit space will be used in the Detroit Exposition to present as complete a cross section of steel, raw material, heat treating equipment, small tools, machine tools, forging equipment, inspection, handling and welding materials as ever has been assembled.

MODERN MANUFACTURING WITH A "STABLE-ARC" WELDER

Modern Manufacturing with a "Stable-Arc" Welder is the title of a 36-page booklet just issued by The Lincoln Electric Company, Cleveland, Ohio. This miniature text book outlines briefly the theory of the use of arc welding in production manufacturing and striking illustrations are reproduced showing recent applications of the arc welding process.

The first part of the book is devoted to the replacing of iron castings by standard rolled steel sections joined by arc welding. There are numerous photographs showing complicated machine parts formerly cast, which are now built up in this manner. It is claimed that the cost of arc welding permits this method of construction because of the initial cost advantages of rolled steel over gray iron castings.

For the purpose of comparing costs the average price of castings is taken as six cents per pound and rolled steel at two cents per pound. A number of typical machine parts are illustrated and detailed cost figures are reproduced tending to show great economy for the arc-welded method of construction. There are other illustrations of complete machines made 99 per cent from arc-welded steel which would formerly be made of cast iron.

In addition to economy, further advantages claimed for arc-welded steel construction are lighter weight, greater strength, elimination of patterns, reduction in material inventory and shorter time required for bringing out new designs.

There are suggestions for redesigning cast parts for arc-welded steel construction and data on arc welding costs. One section of the book is devoted to arc welding in the tool room. Jigs, fixtures, punches, dies and strippers are illustrated which were made by arc welding at a great saving in weight and cost.

While the application of arc welding in place of riveting on tanks, pipe and stills is no longer novel it is something of a shock to see power shovels, locomotive-crane booms, dry pans and similar heavy-duty equipment completely arc welded. There are numerous products illustrated where severe vibration must be guarded against and where manufacturers have been won over to arc welding after comprehensive tests.

Several types of "Stable-Arc" welding machines are illustrated and described. The book is 8½ in. by 11 in. with board covers and is well worth reading.

CHANGES IN LINCOLN ORGANIZATION

The Lincoln Electric Company announce the following changes and additions to their Sales and Service Department.

Mr. L. P. Henderson, formerly connected with the Detroit Office, has been transferred to Chicago in charge of Welder Service.

Mr. J. E. Durstine has been transferred from the Experimental Engineering Department to Welder Service Department at Cleveland.

Mr. J. W. Shugars of the Time Study Department at Cleveland, and Mr. R. D. Layman, also of Cleveland, have been moved to Detroit under the direction of Mr. J. M. Robinson.

Mr. D. H. Carver has been transferred from the Machine Shop Division at Cleveland to the Ohio Service Division with headquarters at Cincinnati.

Mr. R. F. Terrill has been transferred from General Engineering Department at Cleveland to the Eastern Service Division with headquarters at New York.

EFFICIENT ELECTRODE HOLDER BY MATTICE

An electrode holder that is said to be sturdy and strong yet very simple in construction has been produced by the Mattice Engineering Company, Philadelphia. The manufacturers claim a record for this holder, which they call their "Lightning Release Handle," since out of a thousand sent out on approval, only one was returned.

LINDE ISSUES BOOKLET ON PIPE LINES

An excellent little book entitled, "Long Pipe Lines with Oxwelded Joints," has been published by The Linde Air Products Company. To quote the foreword, "This book shows how engneers and managers in the oil and gas industries have attacked and solved the problem of troublesome pipe joints. It quotes their own writings appraising the welded joint, made by the oxy-acetylene process under the proper procedure control. The earlier opinions, dating from 1914 to 1917, are thoroughly substantiated by the record of the passing years."

On each of twenty-eight pages is a photograph of a typical installation, under a variety of conditions, along with a brief comment on what was actually accomplished with welding in each case, followed by the opinion of engineers with gas, oil, or pipe line companies as to the value of welded pipe joints.

NEW INTERNATIONAL OXYGEN CATALOG

A catalog has also been issued of the extensive line of the International Oxygen Company, illustrating their torches, carbon burning outfits, gauges, regulators, and acetylene generators, as well as numerous welding accessories.

TAYLOR AND WINFIELD CONSOLIDATED

Taylor Welder Co., Winfield Electric Welding Machine Co. and Winfield Mfg. Co., all of Warren, O., will be merged into one company under the name Taylor Winfield Corp., effective July 1. An addition to the plant is now under way to increase its output. Albertus C. Taylor is president and

Courtesy of New York Central Railroad

Locomotive Frames Successfully Welded with Tobin Bronze

No stronger proof of the dependable strength of Tobin Bronze welds can be offered than that locomotive frames repaired three years ago with this trade-marked bronze are still in daily use and that locomotive cylinders welded with Tobin Bronze ten years ago are today giving satisfactory service.

Several of the largest railroad repair shops have adopted Tobin Bronze welding as standard practice in repairing broken locomotive frames and cylinders. The low welding temperature required when applying Tobin Bronze usually eliminates pre-heating and dismantling; thus making it possible to repair many engine breaks on the tracks with the least possible interruption to service.

Tobin Bronze welding rods are made exclusively by The American Brass Company and have the trade-mark "Tobin Bronze" rolled in every rod. They may be obtained from leading distributors of welding supplies.

THE AMERICAN BRASS COMPANY
GENERAL OFFICES: WATERBURY, CONNECTICUT
Offices and Agencies in Principal Cities
Canadian Mill: ANACONDA AMERICAN BRASS LIMITED
New Toronto, Ontario

TOBIN BRONZE

REGISTERED U.S. PATENT OFFICE

WELDING RODS

EXCLUSIVELY AN ANACONDA PRODUCT

One Motor That Does the Work of Two

General repair jobs often call for both drilling and grinding, but you don't need two separate tools. The WODACK Combination Portable Electric Drill and Grinder handles both jobs very capably. It's the tool you need.

"Electric Tool Facts" tells all about it. Send for your copy.

Wodack Electric Tool Corporation
4627 W. HURON ST., CHICAGO, ILL.

"WODACK"
Combination Portable
Electric Drill and Grinder
Patented Nov. 1, 1921

general manager of the new company, G. P. Gillmer vice president, J. H. Ewalt treasurer, and N. H. Cobb secretary. Directors are: A. C. Taylor, L. Jennings, Fred W. Platt, N. H. Cobb, J. H. Ewalt, G. P. Gillmer, W. A. Wilson and W. A. Jones.

Classified Ads

Help Wanted—75c per line, minimum 4 lines.
Jobs Wanted—4 lines free.
Other Ads—$1.00 per line, minimum 4 lines.
Counted 8 words to line. Add 6 words for keyed address

Wanted—The address of every gas and electric welder in the United States. Send them to Knight Brothers, 113 S. Oakley St., Chicago, Ill.

For Sale—Service rights on W. K. and W. C. Prest-O-Lite Cylinders, large or small quantities. Alfred E. Corp., 40 Mathewson St., Providence, R. I.

Wanted—A practical welding engineer—a man familiar with the electrical and acetylene fields and capable of demonstrating the use of wire for welding purposes. The man desired must have a knowledge of sales work and be capable of closing sales in the field; handle sales correspondence regarding welding applications and assist other salesmen in general welding sales problems. Address Box 119, care The Welding Engineer.

Position Wanted—Acetylene and Electric Welder with broad experience in job shop, factory maintenance and many lines of production work desires connection with anyone requiring first class all around man. Address Box 120 care The Welding Engineer.

Position Wanted—Experienced on chromium alloys, welded by the electric arc process. Address Box 121, care The Welding Engineer.

Position Wanted—As sales and service man for manufacturer of welding equipment for Denver territory. Experienced welder. Completed thorough course in welding. Have specialized in selling and serviceing and have broad knowledge of trades affiliated with welding. Age, 24; married, in good health. Can give references. Address R. C. Wright, 1625 Logan St., Denver, Colo.

For Sale—63 Searchlight Acetylene Cylinders 275 cu. ft. capacity; in good condition. Will sell all or part at a bargain price. Address—Purchasing Department, The Youngstown Sheet & Tube Co., Youngstown, Ohio.

For Sale—Style E Purox cutting torch; No. 20 Purox welding torch, tips 2, 3, 6, 8, 10, 12. No. 2 oxygen regulator, for cutting purposes. No. 2 acetylene regulator, for cutting purposes. 25 ft. ¼-in. 5-ply red hose and 25 ft. ¼-in. 5-ply black hose. Cylinder wrench. Outfit in good condition. Used six months Cost $156.50 new. Ralph Linger, 3222 W. Jackson

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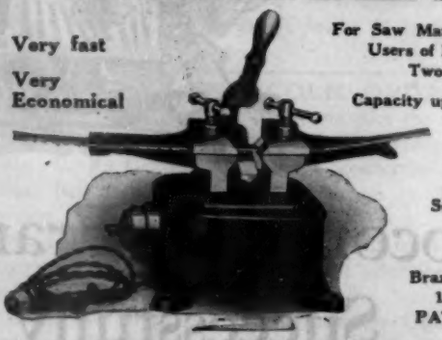
For Sale—

"1—G.E. W.D. 9 complete with or without motor.
1—Westinghouse 500 ampere machine with motor.
1—Lincoln 500 ampere belt drive.
2—200 ampere Lincolns with D.C. motor. Also, 1 with A. C. motor.
3—Standard 220-440 volt 3 phase Lincolns.
1—Air cooled Gibb or Zeus machine.
1—Oil cooled Gibb or Zeus machine.
Bargains in transformer and generator welders of many makes. Please write for rebuilt list."

ELECTRIC ARC CUTTING AND WELDING CO.
152-Jeliff Ave., Newark, N. J.

"Vulcan" Electric Brazer
For Band Saw Blades and similar flat work

Very fast
Very Economical



For Saw Manufacturers and Users of Band Saws. Two Sizes.
Capacity up to 5 inches.

Send for Circular.
Vulcan Electric Brazer & Welder Co.
101 E. 17th St.
PATERSON, N. J.

BUTT Rebuilt Welders SPOT
Guaranteed to be in Perfect Condition

One Thomson 40-A Butt Welder.
One Thomson 9-A Butt Welder.
One Thomson 10-A Butt Welder.
One Thomson 5-A Butt Welder.
One Thomson 2-A Butt Welder.
One Thomson 2-A Automatic Butt Welder.
One Toledo 3 Butt Welder.
One Toledo 137 Spot Welder.

Many Others—WRITE.
TAYLOR-HALL WELDING CORP.
7 May St. Worcester, Mass.

WELDING ROD HOLDER
FOR THE OXY ACETYLENE WELDER
$1.00
ALL STEEL WIRE BRUSHES
SEND $1.00 FOR 5 ASSORTED BRUSHES
Money refunded on return of goods, if not what you want.
WRITE FOR DEALERS' PRICES
C. SORENSEN, 13 E. 16th ST., CHICAGO

"STANDARD" Welding Wire
GAS AND ELECTRIC

for sound permanent welds : : lower costs

Our costs are considerably under those of large industrial centers; ours is a one-profit wire sold direct to user from our own mills exclusively devoted to making of welding wire from raw material to finished product—hence our extremely low prices for wire that is definitely superior. Adopted exclusively by many large users.

Prices on request.

A grade for each type of work—send for samples. Standard Steel & Wire Co., Greensburg, Pa. (Mills at Bolivar, Pa.)

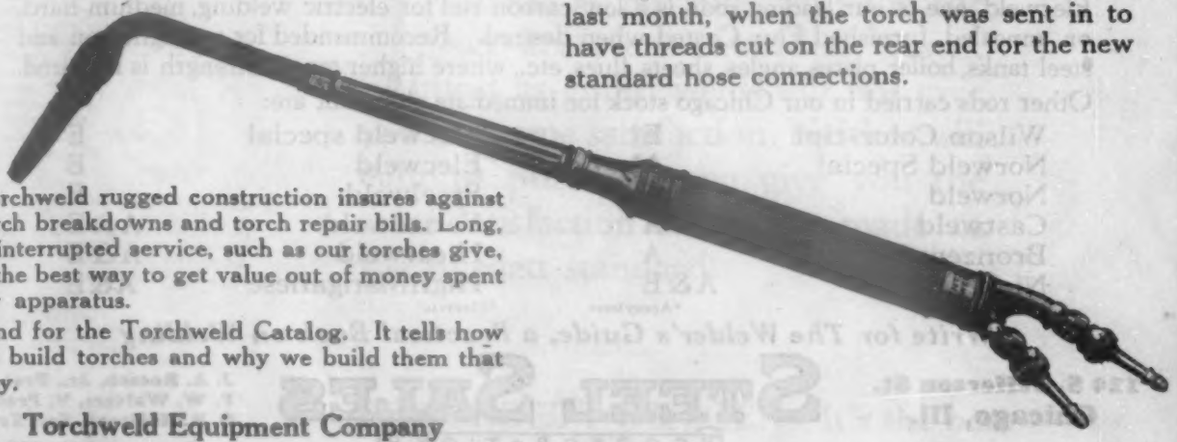
You Can Do It Better With TORCHWELD

Service built into the torch

This one gave ten years' continuous service with no repairs

Some Service Record!

In October, 1917, a large concrete machinery company purchased their first Torchweld non-flash welding torch. It has been in continuous daily service ever since without repairs of any kind being necessary until last month, when the torch was sent in to have threads cut on the rear end for the new standard hose connections.



Torchweld rugged construction insures against torch breakdowns and torch repair bills. Long, uninterrupted service, such as our torches give, is the best way to get value out of money spent for apparatus.

Send for the Torchweld Catalog. It tells how we build torches and why we build them that way.

Torchweld Equipment Company
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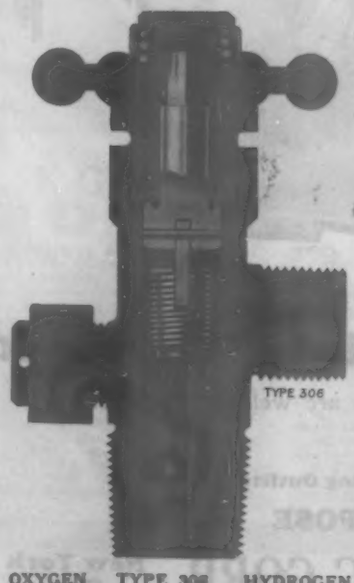

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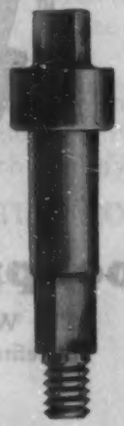

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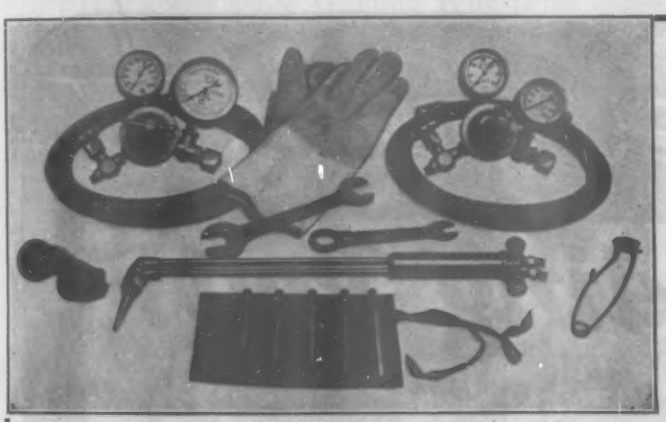

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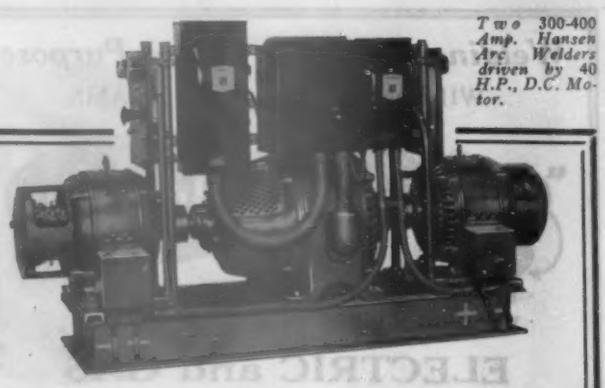

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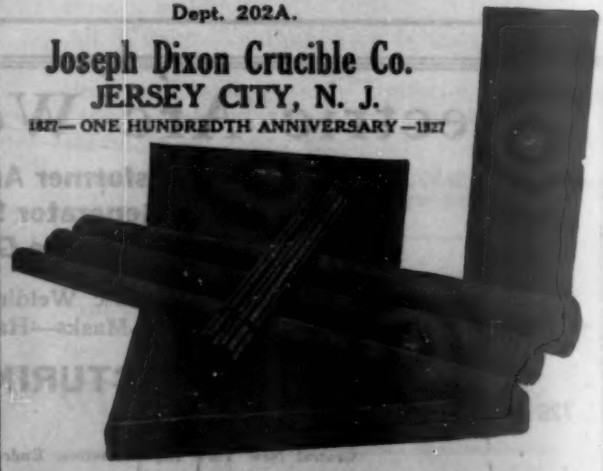

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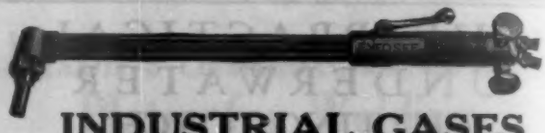

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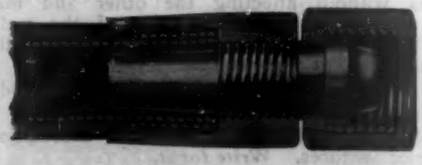

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Parts production increased to 16 pieces per minute by adoption of *ELKONITE* dies on Thompson 75 PA heavy-duty welder.

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In the making of stabilators six welds are made to join the cover and drum. It is obvious that a considerable saving in time and cost would be made if all these welds were made simultaneously by the projection method in which a number of welds are made at each closing of the electrodes. In this method small points or projections are formed of a uniform size on a punch press on the surface of one part where the welds are to be, as shown fig. 3.

Fig. 3—Showing punch press projections which locate spot welds

For this development a standard Thompson 75 PA single spot welder was utilized, and the lower electrode was replaced by a table upon which 6 dies were mounted and which, actuated by a Geneva movement, rotates a sixth of a revolution at the end of each welding cycle.

Dies of various grades of copper were tried and proved to be the weak link in the development on account of being too soft, because after a few welds the projections on the material made impressions in the dies which increased rapidly in size and spread the current away from the weld, resulting in poor quality welds.

Fig. 2—Dark spots show 6 welds made simultaneously

Elkonite, the new electrode material finally gave the satisfactory results; this, on account of the fact that it is a combination of tungsten and copper, having a Brinnel hardness of 225 as compared with 82 for hard copper, and a compressive strength of 208,000 lbs. per sq. in., while that of hard copper is only 58,000 lbs. It is these inherent qualities of ***Elkonite*** which made the Watson experiment successful and increased production possible.

Heretofore copper dies produced but 50 completed pieces, ***Elkonite*** however produces 5000 and more before resurfacing becomes necessary, and ***Elkonite*** can be resurfaced at least 3 times.

The ***Elkonite*** dies are designed so that they may be removed readily, duplicate sets are provided and changes are made on regular schedule, thus minimizing die failure during operation and its consequent loss in production, and work thrown out.

The machine welds at the rate of 16 pieces per minute, nearly 1000 per hour, each piece containing six separate uniform welds made simultaneously, as shown fig. 2. This machine has now been in service several months.

Projection welding may be the solution to your production problems. Our Engineering Staff will be glad to assist you upon request.

For further information write

ELKON WORKS Inc.
Subsidiary of P. R. Mallory & Co. Inc.
Weehawken, N. J.

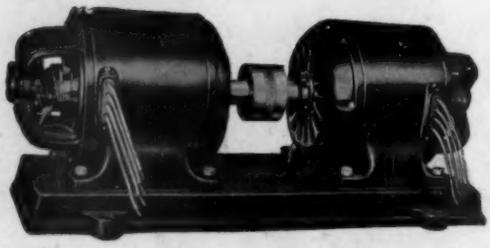
Exclusive licensees under General Electric Co., patents dated May 28, 1925 and Sept. 1, 1925. Other patents pending to Elkon Works, Inc.

WHERE HARD DRAWN COPPER FAILS · ELKONITE STANDS UP

The Job

performed by

Industrial Alternarc



DUALARC MOTOR GENERATOR SET

INDUSTRIAL ALTERNARC TRANSFORMER

Listen in on Alternarc's own story of this job

Mr. Electric: "Hello! Biglow 1600? Mr. Arc, please."

Operator: "Mr. Dual Arc or Mr. Altern Arc?"

Mr. Electric: "I want the one who just finished that house job over in—"

Operator: "Oh, yes, you want Mr. Altern Arc. Just a minute."

Mr. Electric: "Hello, Mr. Altern Arc . . . . Sure, feeling fine. How's your good health?"

Mr. Altern Arc: "Great, as usual. I'm quite simple in construction, and very little can ever go wrong with me. You see, I have no movable parts, and they've made me now so that it is very hard for me to have a complaint—What's on your mind today, Mr. Electric?"

Mr. E: "What's all this I hear about that big residence you welded? Sounds mighty interesting."

Mr. A: "Yes, all of the structural steel work on the job was done by my makers, Electric Arc Cutting and Welding Co. That was quite a big job for a little fellow like me. They made a two-man unit out of me, with two men working off of me and the boys doing all their cutting from me, besides."

Mr. E: "Is that possible! You've certainly made a big step forward in the welding field. But, tell me, how did they get power to operate with? Did they run in special lines for you?"

Mr. A: "Oh, no. These days you can find an A. C power line almost anywhere. They simply hooked us up to the neighborhood lighting line, and away we went."

Mr. E: "But you must have interfered with the light supply in nearby homes."

Mr. A: "Didn't have a complaint. Our operation didn't bother them in the least."

Mr. E: "How did your costs compare with houses built of wood?"

Mr. A: "Well, in spite of all the experimental work, which consumed the greater part of the time, we completed the job for a little less than it would have cost with the usual wood construction."

Mr. E: "Sounds mighty good to me. Say, how can I get all the details on this job? And I'd like to get some more information regarding yourself."

Mr. A: "Fine! Just write to my makers, and they'll give you some figures worth studying. They can also tell you about our full line of accessories, which are the result of years of welding experience."

Mr. E: "All right, Mr. Altern Arc. Thanks for all the dope. You're going to be doing a job for me one of these days. Good bye and good luck!"

Electric Arc Cutting & Welding Company,
152-158 Jelliff Ave., Newark, N. J.

Gentlemen:

Please send me further information regarding the Industrial Alternarc.

Name .....

Address .....

City .....

Electric Arc Cutting & Welding Company

152-158 JELLIFF AVE., NEWARK, N. J.